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AFFDL-TR-78-91 Volume III



RAPID EVALUATION OF PROPULSION SYSTEM EFFECTS Volume III—Derivative Procedure (DERIVP) Users Manual

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BOEING AEROSPACE COMPANY SEATTLE, WASHINGTON 98124

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Unclassified SECURITY CLASSIFICATION OF THIS PAGE (When Date Entered) READ INSTRUCTIONS BEFORE COMPLETING FORM 19 REPORT DOCUMENTATION PAGE 2. GOVT ACCESSION NO. 3. RECIPIENT'S CATALOG NUMBER AFFDL TR-78-91 - Vグレー 3 RAPID EVALUATION OF PROPULSION SYSTEM EFFECTS. DERIVATIVE PROCEDURE (DERIVP) USERS MANUAL. AUTHORIA ONTRACT OR GRANT NUMBER(a) T. E./Hickcox, R. A./Atkins, Jr. W. H./Ball F33615-77-C-3985 PERFORMING ORGANIZATION NAME AND ADDRESS Boeing Aerospace Company A Division of the Boeing Company Seattle, Washington 98124 11. CONTROLLING OFFICE NAME AND ADDRESS Vehicle Synthesis Branch (AFFDL/FXB) Air Force Flight Dynamics Laboratory Wright-Patterson AFB, Ohio 45433 14. MONITORING AGENCY NAME & ADDRESS/II different from 15. SECURITY CLASS. (of this report) Unclassified DECL ASSIFICATION DOWN GRADING IS. DISTRIBUTION STATEMENT (of this Report) Distribution limited to U.S. Government Agencies only; Test and Evaluation; Statement applied 10 July 1978. Other requests for this document must be referred to Air Force Flight Dynamics Laboratory (AFFDL/FXB); Wright-Patterson Air Force Base, Ohio 45433 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report 622 18. SUPPLEMENTARY NOTES NOV **28 1978** 19. KEY WORDS (Continue on reverse side // necessary and identity by block number) Installed engine performance Inlet performance Nozzle performance 20. ABSTRACT (Continue on reverse side if nacessary and identify by block number) This report presents the results of a research program to develop computerized preliminary analysis procedures for calculating propulsion system installation losses. These losses include inlet and nozzle internal losses and external drag losses for a wide variety of subsonic and supersonic aircraft configurations up to Mach 3.5. The calculation procedures used in the computer programs, which were largely developed from existing engineering procedures and experimental data, are suitable for preliminary studies of advanced aircraft configurations. Two interactive computer programs were developed during the

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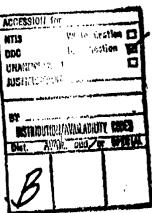
contract: (1) A propulsion installation effects program that calculates installed performance, using input maps of inlet and nozzle/aftbody characteristics for specific configurations, and (2) A derivative program that allows the user to generate new sets of input maps by perturbations to the geometries of the basic input maps. The work accomplished during the contract is documented in three separate volumes. Volume I is a Final Report discussing the analysis methods and data used to develop the programs, and major technical observations from the study. Volume II is a PIPSI Users Manual, containing documentation of the interactive propulsion installation program. Volume III is the Derivative Procedure Users Manual, documenting the methods and usage of the derivative procedure. Volume IV is a library of input maps.

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This report documents the work accomplished during USAF Contract No. F33615-77-C-3085. The work consisted of developing an interactive PIPSI computer program, developing an interactive derivative computer program, and developing and documenting supporting data libraries. The work was accomplished in three phases. As part of the work accomplished in Phase I of the contract, the interactive PIPSI program was completed and delivered to the Air Force. As part of Phase II work, derivative parameters were selected and development work was completed on the derivative program. During Phase III a library of inlet and nozzle/aftbody characteristics was prepared, test cases were completed, documentation was accomplished, and final programs were delivered to the Air Force. The program was conducted under the direction of the Vehicle Synthesis Branch, Air Force Flight Dynamics Laboratory, Air Force Systems Command. Mr. Gordon Tamplin was the Air Force Program Monitor.

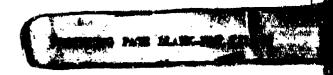
The program was initiated on 17 July 1977 and draft copies of the final reports were submitted for approval on 15 May 1978.

Mr. W. H. Ball was Program Manager for The Boeing Company. The following individuals contributed significantly to the work accomplished during this contract: R. A. Atkins, Jr., computer programming; T. E. Hickcox, inlet derivative procedure development; E. J. Kowalski, inlet configurations and performance; and J. E. Petit and R. M. Trayler, nozzle/aftbody procedure and configurations.



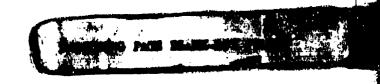
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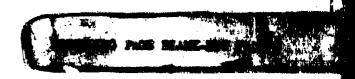
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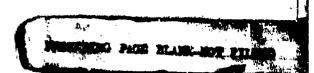
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LIST OF NOMENCLATURE AND SYMBOLS

A*	Sonic area, in2
A	Area, in ²
Ac	Inlet capture area, in2
Ao	Local stream tube area ahead of the inlet, in2
Aoı	Free-stream tube area of air entering the inlet. in2
Æ	Aspect ratio, W _C /H _C for inlets, W _g /H _g for nozzles, dimensionless
CD	Drag coefficient, $\frac{D}{q A_{ref.}}$, dimensionless
С	Sonic velocity; ft/sec.
C-D	Convergent-divergent
C _{DADD}	Additive drag coefficient, $C_{DADD} = \frac{D_{ADD}}{qA_c}$, dimensionless
$c_{D_{A10}}, c_{D_{AB}}$	Afterbody drag coefficient, $\frac{DRAG}{qA_{10}}$, dimensionless
C _D Base	Base drag coefficient $\frac{(P_b - P_{\infty}) A_{base}}{q A_{10}}$, dimensionless
CDA10-A9*	
CDPAP	Drag coefficient, $\frac{D}{q_0(A_{10}-A_9)}$, based on projected area, dimensionless
c _{DS}	Scrubbing drag coefficient, $\frac{DRAG}{qA_{10}}$, dimensionless
CfG	Thrust coefficient, $\frac{F_g}{\frac{d}{g}(V_1)}$ dimensionless
CV	Nozzle velocity coefficient, dimensionless
Conv.	Convergent



D	Drag, lb.; Hydraulic Diameter, $\frac{4A}{P}$, in., diameter, in.
F	Thrust, 1b.
FN	Net thrust, 1b.
FNA	Installed net thrust, lb.
Fgi	Ideal gross thrust (fully expanded), lb.
f/a	Fuel/air ratio, dimensionless
9	Gravitational constant, ft/sec ²
h	Enthalpy per unit mass, BTU/lb.; height, in.
hf an	Enthalpy of fan discharge flow, BTU/1b
^h pri	Enthalpy of primary exhaust flow after heat addition, BTU/1b
ht	Throat height, in ²
IMST	Integral mean slope parameter, truncated
	IMS _T = $-\frac{1}{(1-A_9/A_{10})} \int_{A/A}^{1.0} \frac{d(A/A_{10})}{d(L/D_{eq})} d(A/A_{10})$
L	Length, in.
M	Mach number, dimensionless
P	Static pressure, lb/in ² , perimeter, in.
Pr	Relative pressure,; the ratio of the pressures \mathbf{p}_a and \mathbf{p}_b corresponding to the temperatures \mathbf{T}_a and \mathbf{T}_b , respectively, along a given isentrope, dimensionless
P.S.	Power setting
PT	Total pressure, lb/in2
Q	Effective heating value of fuel, BTU/lb.

LIS: OF NOMENCLATURE AND SYMBOLS (Continued)

q	Dynamic pressure, lb/in ²
R	Gas constant
R, r	Radius, in.
RF	Total pressure recovery
SFC	Specific fuel consumption
SFCA	Installed specific fuel consumption
Т	Temperature, OR
V	Velocity, ft/sec
K	Mass flow, 1b/sec
WBX	Bleed air removed from engine, 1b/sec.
WC.	Corrected airflow, 1b/sec. $\frac{w\sqrt{\theta}}{\delta}$
Ыf	Weight flow rate of fuel, 1b/sec.
₩2	Weight flow rate of air, primary plus secondary, lb/sec.
Wg	Primary nozzle airflow rate, lb/sec.
x	Length, in.
α	Angle of attack; convergence angle of nozzle, degrees
Y	Ratio of specific heats, dimensionless
δ ₁₂	Pressure correction factor, P _{T2} /P _{syo}
ε	Diffuser loss coefficient, $\frac{\Delta P_T}{q}$, dimensionless
0 _{T2}	Temperature correction factor, T_{T_2}/T_{STD} .

LIST OF NOMENCLATURE AND SYMBOLS (Concluded)

 $\theta_{\rm N}$ 2-D Nozzle wedge half-angle

 θ_{P} Round Plug nozzle half-angle

η_B Burner efficiency, dimensionless

ν Kinematic viscosity, ft²/sec.

p Density, 1b/ft3

SUBSCRIPTS

amb Ambient

AB Afterbody

B Burner

 B_X Bleed airflow extracted from the engine

b, base Base flow region

BP Bypass

BLC Boundary layer bleed

btail Boattail

SECTION I

The purpose of the derivative procedure is to provide a first-order analytical method to determine the effects on inlet and nozzle performance of configuration differences from the nearest configuration represented in the library of stored maps (which are built-up for specific configurations). The derivative process is illustrated in Figure 1.

The derivative procedure utilizes analytical and experimental data in determining changes in the stored performance maps that result from geometric changes in the inlet and nozzle/aftbody configurations. The analytical procedures and experimental data have been used to develop an interactive computer program that allows the user to interactively account for changes to the configurations in the library. The program then generates new input data maps in the PIPSI format that represent the performance characteristics of the perturbed configuration. An overlay structure was used to construct the program as shown in Figure 2.

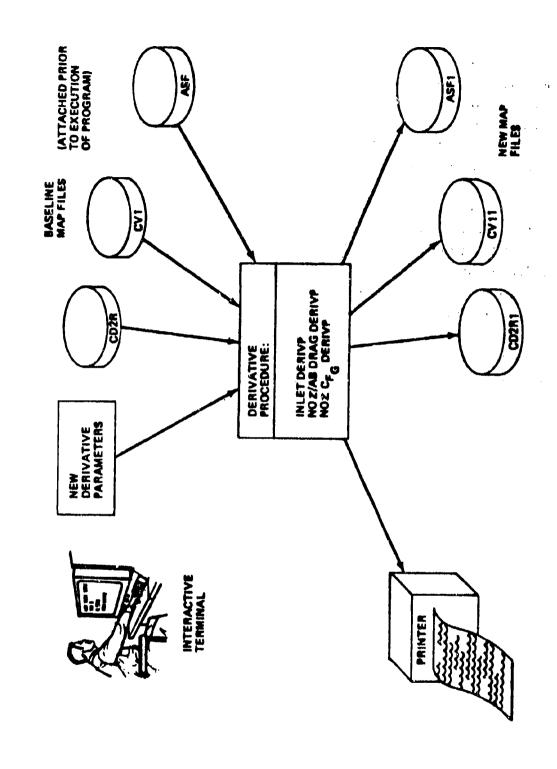


Figure 1. The Derivative Process

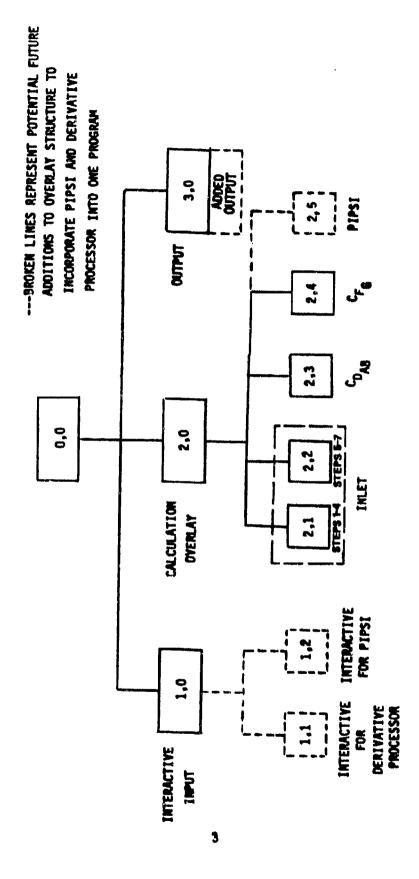


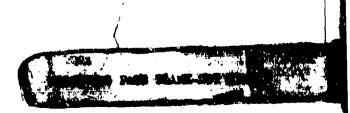
Figure 2. Derivative Procedure Overlay Structure

SECTION II DERIVATIVE PARAMETERS

The first step in the development of the derivative procedure was the selection of the derivative parameters. The derivative parameters are those parameters that will be perturbed to produce a new set of performance characteristics from an existing (or "baseline") set of maps.

The criteria used to select the derivative parameters were:

- 1) Variations in the parameter must have a significant effect on the content of the maps used to describe inlet or nozzle/aftbody performance. The derivative procedure will be used as part of an overall preliminary analysis procedure for calculating firstorder propulsion system installation effects. It should not be used for detailed design studies because the methodology employed in developing the input data for the inlet and nozzle maps, of necessity, requires using a variety of engineering analyses, test data and assumptions based on experience and judgment. The methods employed are believed to be reasonable; however, the procedure may not be sensitive to the effects of small variations in some design variables. The user should ascertain whether or not the procedure will properly evaluate the desired parameter before using the procedure. The derivative parameters selected for the present procedure are those which have been clearly identified by test or analysis as having "first-order" effects on installed performance.
- To the maximum extent possible, an attempt was made to define the derivative parameters in terms of geometric variables that can be easily related to the airplane configuration. This was done to help in evaluating the effects of configuration changes on installed performance.



3) Derivative parameters had to represent trends that were strong enough to be clearly evident in spite of the scatter in test data obtained from typical inlet and nozzle tests.

Table I presents a list of the derivative parameters that have been selected for use in the derivative procedures. The definition of each of these parameters is included. Tables II and III present the derivative parameters and the performance map variables that they affect, either directly or indirectly.

TABLE I

DERIVATIVE PARAMETERS AND THEIR DEFINITIONS

- 1) Aspect Ratio (AR)
- Applicable to two-dimensional inlets only
- Defined as inlet width divided by inlet lip height (relative to tip position).
- 2) Sideplate Cutback (SPC)
- Applicable to two-dimensional inlets only
- Defined as the percent of a full sideplate area that is removed to define a partial sideplate.

The upper edge of a full sideplate extends from the ramp tip to the cowl lip.

- First Ramp or Cone Angle
- Applicable to two-dimensional and axisymmetric inlets
- Defined as surface ramp angle, in degrees, relative to horizontal reference line for two-dimensional inlets

Defined as cone surface angle, in degrees, relative to inlet centerline for axisymmetric inlets (cone half-angle)

TABLE I (Continued)

- 4) Design Mach Number (M_O Design)
- Applicable to all inlets
- Defined as the maximum Mach number at which the inlet is designed to operate
- 5) Cowl Lip Bluntness
- Applicable to all inlets

Defined as the inlet lip surface radius divided by the lip height.

- 6) Takeoff Door Area
- Applicable to all inlets
- Defined as the total door throat area for the takeoff auxiliary air system divided by the inlet capture area
- 7) External Cowl Angle
- Applicable to all inlets

Defined as external cowl surface angle, in degrees, relative to inlet horizontal reference line

- 8) Exit Nozzle Type for Bleed
- Applicable to two-dimensional and axisymmetric inlets
- Defines whether bleed exit nozzle is convergent or convergent-divergent
- 9) Exit Nozzle Angle for Bleed
- Applicable to two-dimensional and axisymmetric inlets
- Defined as bleed exit nozzle angle, in degrees, relative to inlet horizontal reference line

TABLE I (Continued)

- 10) Exit Flap Aspect
 Ratio for Bleed
 (AR_E)
- Applicable to two-dimensional and axisymmetric inlets
- Defined as flap width divided by flap length
- 11) Exit Flap Area for Bleed (A_F/A_C)
- Applicable to two-dimensional and axisymmetric inlets
- Defined as flap area divided by inlet capture area
- 12) Exit Nozzle Type for Bypass
- Applicable to all inlets
- defines whether bypass exit nozzle is convergent or convergent-divergent
- 13) Exit Nozzle Angle for Bypass
- Applicable to all inlets
- Defined as bypass exit nozzle angle, in degrees, relative to inlet horizontal reference line
- 14) Exit Flap Aspect
 Ratio for Bypass
 (AR_F)
- Applicable to all inlets
- Defined as flap width divided by flap length
- 15) Exit Flap Area for Bypass (A_F/A_T)
- Applicable to all inlets
- Defined as flap area divided by inlet capture area
- 16) Subsonic Diffuser
 Area Ratio
 (A₂/A₁)
- Applicable to all inlets
- Defined as exit area (compressor face) divided by entrance area (throat)

TABLE I (Continued)

- 17) Subsonic Diffuser
 Total Wall Angle
- Applicable to all inlets
- Defined as the total equivalent wall divergence angle, from entrance to exit
- 18) Subsonic Diffuser

 Loss Coefficient

 (E)
- Applicable to all inlets
- Defined by the equation

$$P_{T_2}/P_{T_1} = 1.0 - \epsilon \left[1 - \frac{1}{(1 + 0.2 \,\mathrm{M}^2)^{3.5}}\right]$$

- 19) Throat to Capture

 Area Ratio (A_T/A_C)
- Applicable to Pitot inlets only
- Defined as the fixed throat area divided by the inlet capture area

Note: If this parameter is altered and the subsonic diffuser area ratio is not, the compressor face area is scaled with throat area at a fixed capture (lip) area.

- 20) Nozzle/Aftbody Area Distribution
- Applicable to all nozzle/aftbodies. Defined by the cross-sectional area distribution as a function of station from A_{10} (ref. area) to A_9 (nozzle exit area). Characterized by the parameter IMS $_{\rm T}$.
- 21) Radial Tail Orientation Position
- Applicable to all nozzle/afthodies with tails. Defined by the angular orientation of the tail mounting location relative to the vertical position.

TABLE I (Concluded)

- 22) Fore-and-aft Tail
 Location
- Applicable to all nozzle/aftbodies with tails. Defined by the location of the aft point of the tail/aftbody junction relative to the aftbody length $(X_{A_{10}} X_{A_{9}})$.
- 23) Base Area
- Applicable to all nozzle/aftbodies with base area. Defined by the ratio of the base area, A_{BASE}, to the aftbody reference area, A₁₀.
- 24) Plug Half Angle
- Applicable to round plug nozzles. Defined as the half-angle of the plug centerbody measured relative to the plug axial centerline.
- 25) Ramp Half Angle
- Applicable to two-dimensional wedge nozzles. Defined by the wedge half-angle relative to the wedge centerline.
- 26) Aspect Ratio (W_g/H_g)
- Applicable to two-dimensional nozzles, both
 C-D and wedge types. Defined by the ratio
 of nozzle width to height at the nozzle exit
 station.
- 27) Divergence Half-Angle (@ _{DIV})
- Applicable to convergent-divergent round and 2-D nozzles. Defined as the angle of the diverging section nozzle wall relative to the axial centerline of the nozzle.

TABLE II INLET DERIVATIVE PROCEDURE CROSS-REFERENCE (DIRECT AND INDIRECT EFFECTS)

	(DIRECT AND	# 110 A IV	LUI L	CECI	3/			
				PROGR	AH STE	r		
	DERIVATIVE PARAMETER	1	2	3	4	5	6	7
	PENTANIAL AMORIEM	*ox/*c	ع <mark>م ا</mark> من	*v/*c	12 × 120	gbirt C ^D	Comic	CDBAR
1	ASPECT RATIO (FOR 2-D INLETS)	•	•	•	•	•	•	•
2	SIDEPLATE CUTBACK (POR 2-D INLETS)	•	•	•	•	•	•	•
3	FIRST RAMP (COME) AMBLE	•	•	•	•	•	•	•
4	DESIGN MACH NUMBER	•	•	•	•	•	•	•
5	COWL LIP BLUNTWESS	•		•	•		·	•
6	TAKEOFF DOOR AREA	•		•	•			•
7	EXTERNAL COML ANGLE					•		
8	EXIT NOZZLE TYPE FOR BLEED						•	
9	EXIT NOZZLE ANGLE FOR BLEED						•	
10	EXIT FLAP ASPECT RATIO FOR BLEED.						•	
11	EXIT FLAP AREA FOR BLEED						•	
12	EXIT MOZZLE TYPE FOR BYPASS							•
13	EXIT MOZZLE ANGLE FOR BYPASS							•
14	EXIT FLAP ASPECT RATIO FOR BYPASS							•
16	EXIT FLAP AREA FOR BYPASS							•
16	SUBSONIC DIFFUSER AREA MATIO	•		•	•			•
17	SUBSONIC DIFFUSER TOTAL HALL ANGLE	•		•	•			•
18	SUBSONIC DIFFUSER LOSS COEFFICIENT	•		•	•			•
19	THROAT/CAPTURE AREA RATIO (FOR PITOT INLETS)	•		•				

TABLE III MOZZLE/AFTBODY DERIYATIVE PROCEDURE REFERENCE LIST

DERIVATIVE PARAMETER DRAG CALC AFT-END CLOSURE (INCLUDES EFFECT OF ASPECT RATIO, BOAT- TAIL ANGLE, TWIN NOZZLE SPACING RADIAL TAIL ORIENTATION	NOZZLE/AFTBODY DRAG CALCULATION	
AFT-END CLOSURE (INCLUDES EFFECT OF ASPECT RATIO, BOAT- TAIL ANGLE, TWIN NOZZLE SPACING RADIAL TAIL ORIENTATION		GROSS THRUS I COEFFICIENT CALCULATION
RADIAL TAIL	•	
	•	
FORE. AND .AFT TAIL LOCATION	•	
BASE AREA	•	
DIVERGENCE HALF. ANGLE (FOR AXI. SYMMETRIC AND 2-D C-D NOZZLES		•
AXISYMMETRIC PLUG HALF-ANGLE		•
ASPECT RATIO (FOR 2-D C-D AND 2-D WEDGE NOZZLES)		•
WEDGE HAL F.ANGLE (FOR 2-D WEDGE NOZZLES)		•

SECTION III ENGINEERING DESCRIPTION OF DERIVATIVE PROCEDURE

3.1 INLET DERIVATIVE PROCEDURE

The purpose of the inlet derivative procedure is to analytically modify a baseline inlet configuration and define the resulting performance characteristics in a format that can be used as direct input to the PIPSI program. Baseline inlet geometry and performance characteristics will be represented by elements of a set of inlet geometries and performance characteristics contained in the library of map files. The inlet geometric characteristics represented by the inlet configurations contained in the basic library of inlet maps are shown in Table IV. The derivative procedure provides a first-order prediction of the new inlet performance based on the baseline map file and changes in derivative parameters from those of the baseline inlet.

This procedure is based on two key assumptions:

- (1) Generally applicable functions exist which relate changes in inlet performance characteristics to changes in inlet design parameters; and
- (2) The derivative procedure will not alter the sophistication, technology, design philosophy, or mission related design trades that are represented by the baseline inlet. As a result, the inlet level of technology, type of application, complexity and design philosophy are removed as variables in the derivative procedure. It is important to note that as a result of this approach; a new inlet with given design variables will not have completely unique performance characteristics if it is generated by perturbations from different baseline map files. Each result will reflect the design of the chosen baseline inlet.

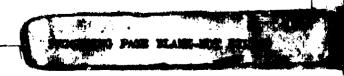


TABLE IV SUMMARY OF INLET CONFIGURATIONS AND DERIVATIVE PARAMETERS

	i							8	CONFIGURATION NUMBERS	ATION	2	E 38							
	NITION NITION	-	~	63	₹	•	•	^	•	•	2	=	12	2	#	=	£	:	=
1 Inhet Aspect Parie	\$	*	*	*	W/W	*	**	-	9	•	***	3	5	;	9	:	!	:	
State Court		1	1					1		?	Ę.	Y	ľ	7	-	•	Š	Ę	Ž
		1	K	\	X	¥.	4	Ķ	Ŗ	Ę	\$	4	%	3	0.0	3	4/8	M/A	X / 3
3 First Rema Angle	ŧ	\$	K,X	\$	K/K	%	٧/٨	7.0	1.3	0.9	Ķ	22.0		7.0	2.0	7.0	#	2	9
4 Design March Number	,	2	5	2	8	3	8	8	2.0	17	8	2.8	2.5	7	8			•	
S Corol Lip Blumbass	A PERSON	B	8	8	8	223	ë	210	210	B	B	50.	910						•
6 Takent Door Area	*	970	0.0	M/A	8	=	Ħ	K	Ŗ	=	¥	*	*	, 2	; 2	; R	, R	, R	_j . R
7 External Court Angle	ŧ	7	7.	12	12	9.	0.	13.0	17.3	17.0	듗	=	7	헕	12		: :		
8 Diesel Enfe Mezzie Type	နှင့် နှင့်	M/A	\$	K/K	*	٧/٨	M/A	. <u>Ĕ</u>	Š	Š	*	Š	8		3	į	ş		3
9 Steed Exit Necrite Angle	ŧ	₹	4 / 3	M/A	XX	M/A	A/N	8	16.0	200	4 / 2	8	#	2	0	1	#	4	2
10 Steed Eart Flap Aspect Radio		₹	¥/k²	\$	M/A	4 / 2	K/N	. 2	22	목	. <u>*</u>	2	=	8	Z,Z	=	9	=	2
11 Blend Eart Play Ave	*	4/8	M/A	R/A	W/W	¥	4	2	5.	Ę	*	2	2	Ŗ	A/A	Ą	R	R	Ŗ
12 Bypess Enit Mocrie Type	33	K /A	K/	W/M	4 / 2	₹/₩	4/4	K / K	į	3	¥	8	į	3	J	3	3	3	3
13 Bryans East Nearts Angle	ŧ	¥,	K/N	K/K	M/A	4/1	×	4/4	35.0	R	4 /4	Ŕ	=	Ŕ	Ę	=	Ħ	#	2
14 Bypun Ent Flap Aspect Rotio	£.	4 / 2	4	K/A	4/4	4/8	4 /8	M/A	2.0	4	W/A	2	5	2	2	•	•	9.	5.
15 Symma Entr Flap Aven	ş	4	*	¥¥	4/4	W/A	\$	K/A	Ŗ	R,	4/8	Ŗ	Ŗ	R	Ŗ	Ŗ	Ŗ	R	Ŗ
16 Subsonic Diffuser Area Rette Ag/A	A2/A1	\$	8.	17	1.28	Ņ	138	7	1.80	=	Ĭ.	<u>=</u>	2.0	<u>.</u>	2	•	1,57	=	4
17 Diffuser Total Well Angle	ŧ	22	2	120	12.0	4,0	97	0.	401	3	9	2	7	=	13			•	1
18 Sebsonic Diffuser Less Conflicient	•	5:	5	Ę	96	21	24	2:	£.	=	Ę	*	2.	2	2	7	: =	2 2	
16 Threst/Capture Ave Ratio	\$/\ \	Ž	4/4	8	ĸ	Ę	8	*	A)	W/A	A/A	\$	4	*	4/4	N/A	4 /	W / W	*
INEST TYPE		į	ş	Į	Į	Į	Ě	n e		남	4	نو	.	ن 2	3	O.		ũ	3
						Ì		2	2	2			Ž	2	ç	0		3	AX
		₹	z E	5		ġ	ĝ	LAL	ATE2	¥	VSTOL	OT TA	THIES		Ē	23.20	5	HAGAS	3

Simplified flow charts are included that provide a basic outline of the procedure and each of its steps. The seven basic steps in the procedure (Figure 3) are ordered in a manner which provides a sequential definition of the new performance maps without the requirement of iteration between later and early steps. A summary of these steps is as follows:

STEP 1

The effect of geometry modification on inlet capture is determined for two-dimensional inlets from the Petersen-Tamplin analysis using a single ramp inlet approximation. For axisymmetric inlets the effects of inlet modification are determined from a single cone analysis. The effect of design Mach number for both these inlet types alters the Mach 1.0 inlet captured mass flow ratio, $A_{\rm O}/A_{\rm C}$, and provides a correction over the supersonic and subsonic Mach number range. For supersonic pitot type inlets, the effect of a change in design Mach number on inlet captured mass flow ratio is calculated using the assumption of fixed throat to lip area ratio.

STEP 2

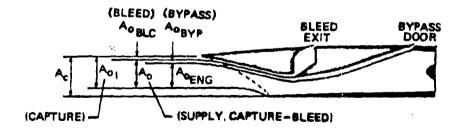
Changes in bleed mass flow caused by design modifications are calculated by accounting for the effects of altered geometry on surface wetted-area ratio and changes in inlet pressure gradient.

STEP 3

"Engine-plus-bypass" supply mass flow ratio, $A_{\rm O}/A_{\rm C}$, is determined simply by reducing the inlet captured mass flow ratio, $A_{\rm O_{RIC}}/A_{\rm C}$, by the required bleed mass flow ratio, $A_{\rm O_{RIC}}/A_{\rm C}$.

STEP 4

Changes in inlet recovery due to geometry modifications are determined from changes in shock losses and subsonic diffuser recovery. The effect of design Mach number change on recovery is determined from the use of the loss coefficient, $\frac{\Delta P_T}{P_T}/q_o$, at equivalent Mach numbers.



- Step 1 Calculate effect of geometry modification and design much number on inlet mass flow ratio, A_{O_T}/A_C .
- Step 2 Calculate effect on boundary layer bleed mass flow ratio, A_{OBLC}/A_C, due to geometry modifications and changes in pressure gradients.
- Step 3 Calculate new inlet supply, A_O/A_C, from new A_{O1}/A_C and A_{OBLC}/A_C.
- Step 4 Calculate effect on inlet recovery due to geometry modifications, design much number, and subsonic diffuser efficiency.
- Step 5 Calculate effect on spillage drag, C_{DSPILL}, of geometric modifications and design mach number.
- Step 6 Calculate effect on bleed drag, C_{DBLC}, of geometric modifications and changes in design much number.
- Step 7 Calculate effect on bypass drag, C_{DBYP}, of geometric modifications and changes in design much number.

Figure 3. Inlet Derivative Procedure Flow Chart

STEP 5

The changes in spillage drag due to design modifications are calculated in a manner similar to the inlet capture mass flow ratio by determining the design change effect for a single ramp or single cone inlet.

STEPS 6 and 7

Changes in bleed and bypass drag due to design modifications are determined by recalculation of the bleed and bypass system drag.

Any step in this process may depend on a previous step, but does not depend on any following step, thereby allowing a non-iterative procedure. Table V summarizes some of the main sources of data and methods used in the inlet derivative procedure.

3.2 NOZZLE/AFTBODY DERIVATIVE PROCEDURE

A nozzle/aftbody drag calculation procedure has been formulated which performs two functions:

- (1) It calculates nozzle/aftbody drag as a function of aft-end closure effects (area distribution will be used as input to reflect the effects of aspect ratio, boattail shape, and twin nozzle spacing), tail position (radial orientation and axial location), and base area.
- (2) Revised nozzle/aftbody drag maps are generated which incorporate the effects of perturbations in nozzle/aftbody geometry on drag. Flow charts showing the major steps in the nozzle/aftbody calculation procedure are presented in Section VI.

The drag calculation procedure begins with an input cross-sectional area distribution for the afthody from which the ${\rm IMS}_{\rm T}$ parameter is calculated for this area distribution. The ${\rm IMS}_{\rm T}$ value is used as input

TABLE V INLET DERIVATIVE PROCEDURE DATA SOURCES

		A THEFT DESTANTIVE PROCEDURE DA	
	PARAMETER	SOURCE OF DATA	EXAMPLE
1.	ASPECT RATIO (FOR 2-D INLETS)	ANALYTICAL CALCULATION USING METHODS OF AFAPL-TR-66-30	
		CHANGES IN ASPECT RATIO AFFECT: 1. A _{OBLC} /A _C (WETTED AREA) 2. A _{OI} /A _C 3. P _{TZ} /P _{TO} 4. ADDITIVE DRAG	
2.	SIDEPLATE CUTBACK (FOR 2-D INLETS)	ANALYTICAL CALCULATION USING METHODS OF AFAPL-TR-66-30 (SAME AS ABOVE)	
3.	FIRST KAMP ANGLE (2-D INLETS)	ANALYTICAL CALCULATION USING METHODS OF AFAPL-TR-66-30	
	FIRST CONE ANGLE (AXISYMMETRIC INLETS)	ANALYTICAL CALCULATION USING AN AXISYMMETRIC CALCULATION PROCEDURE SIMILAR TO 2-D PROCEDURE ABOVE. AFFECTS: 1. AOBLC/AC 2. AOI/AC 3. PIZ/PIA	

TABLE V INLET DERIVATIVE PROCEDURE DAYA SOURCES (cont.)

	PARAMETER	V INLET DERIVATIVE PROCEDURE DAY SOURCE OF DATA	EXAMPLE
4.		MACH MIMBER EQUIVALENCE RELATIONSHIPS. ADBLC/AC CHANGES BECAUSE PRESSURE GRADIENT CHANGES. PT2/PT0 CHANGES BECAUSE TIP SHOCK LOSS CHANGES AT MODES. AOI/AC CHANGES BECAUSE SONIC MASS FLOW CAPABILITY GOES DOWN AS MO INCREASES. MAX OBTAINABLE THROAT AREA RATIO, AT/AC, TYPICALLY IS SMALLER AS MO INCREASES.	PTZ PTO MO GEOMETRIC CHANGES FIRST TWEN MACH NUMBER EFFECTS AOI Ac MO
5.	COML LIP BLUNTNESS	LOW-SPEED PROCEDURE DOCUMENTED IN AFFOL-TR-72-147.	

TABLE V INLET DERIVATIVE PROCEDURE DATA SOURCES (cont.)

Γ	TABLE V INLET DERIVATIVE PROCEDURE DATA SOURCES (cont.)					
	PARAMETER	SOURCE OF DATA	EXAMPLE			
6.	TAKEOFF DOOR AREA	LOW-SPEED PROCEDURE DOCUMENTED IN AFFDL-TR-72-147	$\frac{P_{T_2}}{P_{T_0}}$ $\frac{WV\theta_{T_2}}{\delta_{T_2}A_T}$			
7.	EXTERNAL COWL ANGLE	CORRELATION DEVELOPED FROM EXPERIMENTAL DATA THAT RELATE EXTERNAL COWL ANGLE TO KADD	K _{ADD}			
8.	(FOR BLEED)	NOZZLE CAN BE EITHER CONVERGENT C CONVERGENT/DIVERGENT USED IN MOMENTUM DRAG CALCULATION ANALYTICAL METHODS DOCUMENTED IN AFFDL-TR-72-147 AND PITAP BLEED RECOVERY				
	FOR BLEED	USER CAN SELECT NOZZLE EXIT ANGLE FOR MCMENTUM DRAG CALCULATION ANALYTICAL METHODS DOCUMENTED IN AFFDL-TR-72-147				

TABLE V INLET DERIVATIVE PROCEDURE DATA SOURCES (cont.)

	IABLE	THE DERIVATIVE PROCEDURE DATA	
	PARAMETER	SOURCE OF DATA	EXAMPLE
10.		AND ASPECT RATIO IS A USEA INPUT AND IN USED TO CALCULATE FLAP ENAC FLAP DRAG IS CALCULATED BY METHODS DOCUMENTED IN AFFDL-TR-72-147	I AR=10 I
11	EXIT FLAP AREA FOR BLEED	FLAP AREA IS A USER INPUT AND IT IS USED TO CALCULATE FLAP DRA FLAP DRAG CALCULATION METHODS ARE DOCUMENTED IN AFFDL-TR-72-147	G. C _p = C _p (A _F)(sin θ _E) (A _C)
12	EXIT NOZZLE TYPE FOR BYPASS	NOZZLE TYPE CAN BE EITHER CONVERGENT OR C-D. USED IN MOMENTUM DRAG CALCULATION. ANALYTICAL METHODS DOCUMENTED IN AFFDL-TR-72-147	[₽] T _E / [₽] T _O
13	EXIT NOZZLE ANGLE FOR BYPASS	USER CAN SELECT NOZZLE EXIT ANGLE USED IN MOMENTUM DRAG CALCULATION ANALYTICAL METHODS DOCUMENTED IN AFFDL-TR-72-147	THROAT CONV NOZ C - D NOZ M0

TABLE V INLET DERIVATIVE PROCEDURE DATA SOURCES (cont.)

	IABLE V	INLET DERIVATIVE PROCEDURE DATA	
	PARAMETER	SOURCE OF DATA	EXAMPLE
14.	EXIT FLAP ASPECT RATIO FOR BYPASS	FLAP ASPECT RATIO IS A USER INPUT USED TO CALCULATE FLAP DRAG. FLAP DRAG IS CALCULATED BY METHODS DOCUMENTED IN AFFOL-TR-72-147.	AR = 1.0
15.	FOR BURLES	EXIT FLAP AREA IS IMPUT BY USER. FLAP AREA IS USED IN FLAP DRAG CALCULATION. CALCULATION METHODS ARE DOCUMENTED IN AFFOL-TR-72-147.	C _D = C _p A _C (sin 9 _E)
16.	SUBSONIC DIFFUSER AREA RATIO	SUBSONIC DIFFUSER DATA CORRELATIONS RELATING DIFFUSER TOTAL PRESSURE RECOVERY TO DIFFUSER AREA RATIO. DATA SOURCES: NWCTP5555. AFFDL-TR-69-21, RM L56F05.	28 _W = 10°0
17	SUBSONIC DIFFUSER	SUBSONIC DIFFUSER DATA CORRELATIONS RELATING DIFFUSER TOTAL PRESSURE RECOVER' TO DIFFUSER TOTAL WALL ANGLE. DATA SOURCES: NWCTP5555 AFFDL-TR-69-21, RM L56F05.	A ₂ /A ₁ = 1.5

TABLE V INLET DERIVATIVE PROCEDURE DATA SOURCES (concluded)

	(ABC 4	INLET BERTVATIVE PROCEDURE DATA S	
	PARAMETER	SOURCE OF DATA	EXAMPLE
18.	1	DIFFUSER LOSS COEFFICIENT IS AN OPTIONAL INPUT BY THE USER. DIFFUSER RECOVERY IS THEN CALCULA BY AN EQUATION RELATING ϵ , M ₁ , ϵ P _{T2} /P _{T1} P _{T2} /P _{T1} 1 - ϵ (1 - $\frac{1}{(1 + .2M_1^2)^{3.5}}$)	
19	A _T /A _C (FOR PITOT INLETS ONLY)	INPUT A _T /A _C IF DIFFERENT FROM LIBRARY VALUE USER MUST CONSIDER EFFECT OF AREA RATIO ON INLET CAPTURE, SINCE THE INLET THROAT MACH NUMBER IS HELD CONSTANT	A7/Ac Mo

to data correlations which provide nozzle/aftbody drag as a function of IMS_T , Mach number, and exhaust nozzle exit static pressure ratio. Data correlations based on IMS_T parameters are available for certain classes of installations, namely:

- (1) Single, isolated axisymmetric configurations
- (2) Twin axisymmetric configurations
- (3) Single 2-D wedge nozzle configurations
- (4) Twin 2-D wedge nozzle configurations

The data correlations listed above are used to predict drag of similar configurations within the limitations of the data correlations. Input requirements must be fairly detailed because an accurate cross-sectional area distribution must be available as input to compute the IMS_T parameter.

After obtaining the basic nozzle/afthody drag from the IMS $_{\rm T}$ correlations, drag corrections are added to account for the radial orientation of tails, longitudinal location of tails, and base drag. The total drag is then calculated as the sum of the individual drag contributions. The drag calculation process is repeated for both the old (baseline) configuration and the new (perturbed) configuration. The incremental drag difference is then added to the old (baseline) drag map to produce a new drag map for the new (perturbed) configuration.

3.3 NOZZLE GROSS THRUST COEFFICIENT DERIVATIVE PROCEDURE

Using the calculation procedure built into this program, incremental changes in nozzle geometric variables are made by the user and the resulting changes in C_{F} are calculated. The program then adds the incremental changes in nozzle C_{F} to the old (baseline) C_{F} map to obtain the C_{F} map for the new configuration.

The calculation methods used to determine the effects on nozzle gross thrust coefficient (C_F) of changes in nozzle geometric variables depend greatly on the type of nozzle being used. Separate calculation flow paths were constructed to handle each of the following nozzle types:

- (1) Axisymmetric Convergent-Divergent
- (2) Axisymmetric Plug
- (3) Two-Dimensional Convergent-Divergent
- (4) Two-Dimensional Plug (Wedge)

The derivative parameters for each nozzle type are:

NOZZLE Type		DERIVATIVE PARAMETERS
AXI C-D	B DIA	DIVERGENCE Half-Angle
AXI PLUG	<i>6</i> p	PLUG HALF-ANGLE
2-D C-D	₩g/Hg ₩g/Jy	ASPECT RATIO DIVERGENCE HALF-ANGLE
2-D WEDGE	₩9/H9 # N	ASPECT RATIO RAMP (WEDGE) HALF-ANGLE

The user of the derivative procedure has the options available to calculate the effect on the input C_F map of any of the derivative parameters shown in the right hand column above. The methods and data used to calculate the effects of variations in each of the derivative parameters are described in the sections which follow.

3.3.1 Effect of Divergence Half-Angle on $C_{\mathsf{F}_{\mathsf{G}}}$ for a Round C-D Nozzle

The input map format for round C-D nozzles used by the PIPSI program is illustrated in Figure 34. This map provides C_F as a function of nozzle pressure ratio, P_{T8}/P_o , for various nozzle expansion ratios, P_{T8}/P_o , and P_{DIV}/P_o could be related to area ratio, a typical round C-D nozzle P_{DIV}/P_o variation as a function of P_{T8}/P_o was adopted for programming into the procedure. With a knowledge of P_{T8}/P_o and P_{T8}/P_o , it is possible to determine the angularity loss, using the experimental angularity loss coefficient data shown in Volume I.

3.3.2 Effect of Plug Half-Angle on $C_{\overline{F}_G}$ for a Round Plug Nozzle

The input map format for an axisymmetric plug nozzle provides nozzle gross thrust coefficient, C_{FG} , as a function of nozzle pressure ratio P_{T8}/P_0 for various area ratios, A_g/A_g . To obtain the relationship of A_g/A_g and plug half angle, a two-dimensional table look-up set of data was prepared that represents the geometric relationships between lip angle, α , plug half angle, θ_p , and area ratio, A_g/A_g , for a typical plug nozzle configuration. These data were programmed into the code to provide data necessary to calculate the parameter $(\alpha - \theta_p)$ used in the data correlation that provides the plug nozzle performance loss. This correlation, documented in Volume I, is based on experimental data.

3.3.3 Effect of Aspect Ratio and Divergence Half-Angle on C_F for a Two-Dimensional Convergent-Divergent Nozzle

The methods used in developing the computer code for the 2-D C-D nozzle internal performance calculations are based primarily on the experimental data gathered during the AFAPL Installed Turbine Engine Survivability Criteria contract. These tests provided data on a variety of 2-D nozzles of various aspect ratios and divergence angles.

The input map format for the 2-D C-D nozzle provides nozzle C_F as a function of pressure ratio and nozzle jet area. Two jet area Schedules are provided, minimum jet area and maximum jet area, corresponding to the experimental configurations tested. An optimum schedule of area ratio is used for each of the jet area settings. The area ratio schedule is truncated at a maximum area ratio of 1.60, corresponding to the maximum area ratio used in the tests. A divergence angle schedule was also obtained from the test configurations. With the geometric relationships provided by the previous A_9/A_8 and $\theta_{\rm DIV}$ schedules, the necessary input parameters are available to obtain C_F as a function of A_9/A_8 and $\theta_{\rm DIV}$ from a correlation of experimental data. The values for old and new configurations provide the data needed to obtain the ΔC_F resulting from the geometric change in $\theta_{\rm DIV}$. The data plots are presented in Volume I.

The experimental data were also used to obtain the effect of nozzle aspect ratio. These data, presented in Volume I, provide a correction factor, C_{Γ}/C_{F} as a function of Log R for minimum and maximum jet area settings.

3.3.4 Effect of Aspect Ratio and Wedge Half-Angle on C_F of a 2-D Wedge Nozzle

The format for 2-D wedge nozzle PIPSI input data maps provides $C_{F_{\rm G}}$ as a function of nozzle pressure ratio, $P_{\rm T8}/P_{\rm O}$, for two nozzle area ratio schedules, one for non-afterburning operation and one for maximum afterburning operation. These schedules assume that variable area nozzle geometry is available such that the nozzle area ratio can be scheduled to operate at the optimum value until the geometric limits of nozzle travel are reached.

Experimental data were used to provide the correction factors for 2-D wedge nozzle aspect ratio and wedge angle. The data used in the computer program were prepared as correction factors relative to the baseline values of a wedge angle, ϑ_p , of 10^0 and an aspect ratio, Δ , of 1.0. The resulting correction factors are presented in Volume I.

Flow charts are presented in Section VI which show the calculation procedure used to calculate the new nozzlé $\mathbf{C}_{\mbox{F}_{\mbox{G}}}$ maps.

SECTION IV PROGRAM INPUT AND EXECUTION

The derivative procedure program (DERIVP) is an overlay program written in Extended Fortran IV (FTN) for the ASD CDC NOS/BE computer system. The program is run exclusively in an interactive mode in under 60K octal words of memory.

The inputs to the program consist of maps and derivative parameters on disk files which are attached prior to program execution. User inputs to modify particular derivative parameters are made through interactive input.

The output of the program consists of printed results and a PIPSI input file. The user may select the creation of these output via an interactive input.

4.1 TABLE FORMATS

ine values in the tables are stored on disk in a 10F7.0 card format. The meanings of the quantities placed in a card image differ depending on the type of table. There are four table types:

- a) one-dimensional
- b) two-dimensional (symmetric)
- c) two-dimensional (non-symmetric)
- d) three-dimensional

In all the input tables the independent variables must always be in increasing order.

4.1.1 One-Dimensional Table Definition

Card 1	Table Definition Card	Format
Cols.		
1-7	Table Name	A7
8-14	Number of X Values	F7.0
Card 2	X Values	
Cols.		
1-7	X ₁	F7.0
8-14	x ₂	F7.0
•	•	• .
•	•	•
•	•	•
•	•	•
•	•	•
64-70	x ₁₀	F7.0
Card 3	Table Values	
°Cols.		
1-7	f(x ₁)	F7.0
8-14	$f(x_2)$	F7.0
•	•	•
•	•	•
64-70	f(x ₁₀)	F7.0
	10	
4.1.2	Two-Dimensional Table Definition (Symmetric)	
Card 1	Table definition Card	Format
Cols.		
1-7	Table Title	A7
8-14	Number of X Values	F7.0
15-21	Number of Y Values	F7.0

Cord 2	Y Values	
1-7		
8-14	Y ₁	F7.0
	Y ₂	F7.0
•	•	•
	•	•
64-70	, y	
	Y ₁₀	F7.0
Card 3	X Values	
Cols.		
1-7	x ₁	F7.0
8-14	x ₂	F7.0
•	•	17.0
•	•	
•	•	•
64-70	^X 10	F7.0
Card 4	Table values for Y ₁ , and	
Cols.	all X values	
1-7	f(x ₁ ,y ₁)	. F7.0
8-14	$f(x_2, y_1)$	F7.0
•		. ,
•	•	•
•	•	
64-70	$f(x_{10}, y_1)$	F7.0
Card 5	Table Values for Y ₂ and	
Cols.	all X Values	
1-7	f(x ₁ ,y ₂)	F7.0
8-14	$f(x_2,Y_2)$	F7.0
•	•	
•	•	•
64.70	•	•
64-70	f(₁₀ ,y ₂)	F7.0
	Etc. for additional Y values	

~ 4.1.3 Two-Dimensional Table (Non-Symmetric)

Card 1	Table Definition Card	Format
Cols.		
1-7	Table Name	A7
8-14	Number of Y Values	F7.0
Card 2	Number of X Values for	·
Cols.	A Particular Y Value	
1-7	NX (Y ₁)	F7.0
8-14	NX (Y2)	F7.0
•	•	•
•	•	•
•	•	•
•	. •	•
64-70	NX (Y ₁₀)	F7.0
Card 3	Y Values	
Cols.		
1-7	Y ₁	F7.0
8-14	Y ₂	F7.0
•	.	•
•	•	•
•	•	•
64-70	Y ₁₀	F7.0
Card 4	X Values for Y ₁	
Cols.	-	
1-7	X ₁ (y ₁)	F7.0
8-14	$X_2(y_1)$	F7.0
•	•	•
•	•	•
•	•	•
64-70	$X_{10}(y_1)$	F7.0

Card 5 Cols.	Table Values for (X_1-X_{10},Y_1)	
1-7 8-14	f(X ₁ ,Y ₁) f(X ₂ ,Y ₁)	F7.0 F7.0
•	• • • • • • • • • • • • • • • • • • • •	•
64-70	f(X ₁₀ ,Y ₁)	F7.0
Card 6	X Values for Y ₂ (see Card 4)	
Card 7	Table Values for (X_1-X_{10},Y_2) (see Card 5)	
4.1,4	Three-Dimensional Table Definition	
Card 1	Table Definition Card	Format

Card 1	Table Definition Card	Format
Cols.		
1-7	Table Name	A7
8-14	NX ≈ number of X values	F7.0
15-21	NY = number of Y values	F7.0
22-78	NZ = number of Z values	F7.0
Card 2	X Values	
Cols.		
1-7	x ₁	F7.0
8-14	x ₂ ·	F7.0
•	•	•
•	•	•
•	•	•
64-70	X ₁₀	F7.0

Card 3	Y Values	
Cols.		•
1-7	Υ ₁	F7.0
8-14	Y ₂	F7.0
•	•	•
•	•	•
• 64-70	•	•
04-70	Y ₁₀	F7.0
Card 4	Z Values	
Cols.		
1-7	z ₁	F7.0
8-14	22	F7.0
•	•	17.0
•	•	• -
	•	
64-70	² 10	F7.0
Card 5	Table Values for Y_1 , Z_1 ,	
Cols.	and all X Values	
1-7	f(X ₁ ,Y ₁ ,Z ₁)	F7.0
8-14	$f(X_2, Y_1, Z_1)$	F7.0
•		17.0
•	•	•
•	•	•
64–70	$f(x_{10}, Y_1, Z_1)$	F7.0
Card 6	Table Values for Y2,Z1	
Cols.	and all X Values	
1-7	f(X ₁ ,Y ₂ ,Z ₁)	F7.0
8-14	$f(X_2,Y_2,Z_1)$	F7.0
•		17.0
•	•	•
•	•	• -
64-70	f(X ₁₀ ,Y ₂ ,Z ₁	F7.0
Etc. unt	il Y Values have been gone through	

Card 5+NX Cols.	Table Values for Y_1, Z_2 and all X Values	
1-7	f(X ₁ ,Y ₁ ,Z ₂)	E7 A
8-14	$f(X_2, Y_1, Z_2)$	F7.0
•	1,2,1,2,	F7.0
	•	•
•	•	
•	•	•
64-70	f(X ₁₀ ,Y ₁ ,Z ₂)	•
Etc. until all	Y and Z Values have been gone through	F7.0

4.1.5 Table Examples

Examples of tables in each of the first 3 formats are shown in Figure 4, and an example of the three-dimensional table format is shown in Figure 5.

		INDIE E							
		.5 5	.7	.8	1.2	1.6	2.0		
		1.055	.935	.89	.846	.89	036	;	
				Tabl	e Type	1			
Tabl	es 7.	8.							
0.	.8489	.85	1.0	1.2	1.4	17	,	20	
U.	-04	.08	.12	.16	.20	24	٤.	20	
U.	0.	0.	0.	0.	0.	ο.			
O.	0,	0.	0.	0.	0.	n.			
u.	.062	.125	.198	.28	.38	.50			
v.	.05	.10	. 156	.217	.29	.379	5		
0.	.036	.075	.117	.162	.22	.29			
0.	.03	.062	.097	.135	.185	.241	L		
σ.	.025	.052	.081	.116	.16	.216	,		
0.	-02	.045	.074	.11	.153	.21			
TABL	E2A6			Table 1	ype 2				
	6.	7	-	_					
.55	0. ∩ל	95	/. 1 m	8,	9,	_			
.7	.70	.03	1.20	1.60	2.()			
.001	.8 5 001	.7	1.0	1.05	5 1.(775	1		
.6	5 .991 .7	, 705 0	•909 •	.95	.93	33	.875		
.99	.7 .99	005	.7	.95	. \$7	,			
.5	.6	7	.3/4	. 745 20	.90				
.99	.99	_ GR G	403	• 50 678	. 87	5			
	.6	.7	.983				.9 0		
.98	.979	.977	.8 072	. 85	.8		. 902		
.500	. 600			.967			.90		
.975	.970		.800		-		.885	.890	
.5	. 6	.7	.958				.925	.900	
.958				.9		_	. 9 35	.943	.95
	• 303	.949		.935		25	.92	.900	.85
			•	Table T	ype 3				

Table 2E6

Figure 4. Examples of Three Table Types

TABLEAB2. 2. 2. 1. 2. 1. 2. 1. 2. 1. 1. 1. 1. 1. 1. 1. 2. 2. 2. 2. 2. 2. 2. 2.

Figure 5 Example of a Three-Dimensional Table

4.2 DISK FILES

The derivative procedure program utilizes three input disk files and two output disk files for program data communication. The user governs the usage of these disk files by responding to prompts when executing the program.

4.2.1 Input Disk Files

Three disk files must be attached prior to program execution in order to run all maps necessary for a PIPSI execution. These files are as follows:

TAPE 51 - Inlet maps and Inlet Derivative Parameters

TAPE 52 - Afterbody Drag Map and Derivative Parameters

TAPE 53 - Nozzle Thrust Coefficient (C_F) Map and Derivative Parameters

Only the disk files needed to run the desired maps need to be attached before executing the program.

4.2.1.1 Inlet File (YAPE 51)

This disk file consists of four separable sections of input:

- 1) Inlet Title Card
- 2) Inlet Derivative Parameters
- 3) Non-changeable Inlet Parameters
- 4) Inlet Tables

Figure 5 shows an example of a typical inlet file

4.2.1.1.1 Inlet Title Card

An 80-character title card must be the first card of the inlet file. It is read with an A format and is printed as a heading on the output data.

C •	0 •	22.	2.	-015	-46 -1-83	19.	1.0	20.	1.0
D •	1.3	3.0	.75						
TABLES									
g D.		2.0							
U. Tableza		2.0							
		-10	-10	40	-10				
			1.4		1.6	2.0			
		.7479	.7904		-8460	. 455 &	-8653	.8695	.8696
• 7787		- 		-7644 -7294			• 7565	V137 - 7588	
.9879·				19598			.9423		-8673
		-4363-				-1110-	7481_	7410 -	
					.7532		. 7430		
.5462	.6463	.6627	-7132	-7485	.7673		.7845		.7882
		9714 -6780							
		.9666							
-6230	-6478-	,7724	4230	8489	 5801		4745	3967	89 79-
		.9579							
-6965	.7687	.8227	.8834	.9225	.9465	•9627			
• 7 60 3 Table 28		4465	 ₽42₽	42 11	4222	7278	9211		
		.4305	-5-80	.6551	.9488	1-1617	3-4746	1.7112	1-991
		-9637-							
TABLE 2C	10.								
•4477	.5319	.6523	.7361	.7909	.8764	1.0180	1.2124	1.5834	1.982
1- 000# Table2d		7763-	7348	7:17-3	6997	~~ 2 761~~	72 BE	8121-	 742b
		1.4354	1.4775	15510	1-6344	1.7074	1.7904	1.8735	1.997
		-5682-							
TABLEZE	10.								
•\$338		-8576							
TABLE3 2.	2001	10.	10.	10.	10.	10-	10-	10.	10-
	-59	-60			1-06		. 16	-1-1	-2.0
	1.0		-				-		
8.0 v3.0	0.0								
	1~9			******					
		-417	-445	.479	-503	-548	-568	-586	1.0
.351	. 383	-416	•45	.49	.528	.606	. 639		
	• 1			.05				.00	.00
•344 •179	• 384	422	- +963	.077		4 77 2		74 6	
	.374	.442	• 4B8	•531	.579	.621			•00 1•0
		-149							
.325	. 39	.443	.51	.564	.617	.716	. 754		1.0
		-241	-195	.156	•18	. 951	. 022	-001	3.0
								•	
	.518 .504	.431 .563	•357 •414	.287 .673	.22 .728	.094 .786		0.0 .91	#.0 1.0
		~-535		364	279		452		
	-564			-753				. 77	1.0

Figure 6. Inlet File Example

-TABLES					.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				
0.0	• 6	• 7	• B	1.0	1.2	1.6	5.0		
0.0	0.0	.04	. 068	.09	.074	.034	.002		
	88					بيال . ـــــــ			
U - 0	a 4 0	1.0	1.2	1.4	1.6	1.8	2.0		
.743	.743	•743	• 752	.785	.639	.907	. 99		
		7. 7							
3 •	. 85	2.	**	0.200	2026		0440		
.0800	.0037	.0097		-0199			.0642		-1073 0148
	•0099	-0184	.0219	.0249			.0265		
.0000	.0099	.0184	.0219	. UZ49	.0273	-0281		.0236	· £ 398
-FABLES		-4							
	1.2	1.7	2.0						
D • D	. 04	. 08	.12	.16	.20	J24			
-0-0	-05			-4.7	-+66	87			
0.0				-405	.57				
Ü • Ö	.024	.093		.331	.478	-635			
-9.0			10 5	- • 1.75	258	-348			
TABLE 6		- ^	10.	• •					
2.	2.		•						
	1.0		raff. & Alexander	- 1 +0 ···-	E • U	h-1	. 48 - 47 - 4 m 1 m. 1 M. 1 M.		
0.0	0.0								
									
0.0	0.0								
.4991	.5344	.5570	-5808	.6847 .	.6311	.6562	.6776	.6952	.7153
0216	0184-		3136 ···	_+0110	0086	.0059-	0040 .	U022 ·	2003
		.5677							1.0006
-0320		.02R6	.0271	.0252	.0227		.0134	_	.0051
5917								-	1.0009.
	.0431	.0397		-0327			.0201		.0072
.4980 0663	-6476	.760£		.9145			.9711		1.0012
TABLES			# #					~	
		1.1286	1.2431	1.3575	1.4875	1.6072	1.7322	1.8571	1.9976
									0501
TABLET									
2•	2.	10.			10.				
		-1-1	1.2	-l-4	-1.6		2 • 0		
.3981									
.00	0 e D								
3981	0.0	•	·						
.3981		. 4546	-4860	.5249	.5689	. 411K	.6505	.6793	.7032
3025						-0918		.0250	- 9006
.3983	.4321	.4660	.5025	.5414	.5778	-6205	.6594	.6895	.7159
.3178	-2818	. 2484	.2125	1739	.1379	.0968	. 0583	.0287	4441
3 58 /									
.3559	.3174	-2801	.2364	-1940	.1606	.1221	.0835	.0424	0.0
.3967	.4544	.5021	6448.	.5951	·6352·		.7281	.7658	.8085
4 481-				2140		-1318	. 0804	.0419	. DODB .
.3973	n 46 39	.5204	.5731	•62R3	•6836	•7338	.7853	.8241	-RG93
.4678	·4335	.3463	.2943	.2391	-1864	.1350	-0849	.043B	-0001
\$968 5590	-4657		6062 •3334		•2152 •2152		. 6374	+0482	9391
45520	6 7 D D /	47310	12227	96173	0 4 1 3 6	.1612	• U 7 7 D	+ V762	0.0

Figure 6. Inlet File Example (concluded)

4.2.1.1.2 <u>Inlet Derivative Parameters</u>

The inlet derivative parameters provide the basic information describing the configuration in terms of its important parameters. These data are used by the derivative program as a starting point from which a new configuration performance is derived.

Card 1	Parameter Definition	Format
Cols.		
1-7	Aspect Ratio (2D)	F7.0
814	Sideplate Cutback (2D)	F7.0
15-21	First Ramp (cone) angle (deg)	F7.0
22-28	Mach Number	F7.0
29-35	Cowl Lip Bluntness	F7.0
36-42	Takeoff Door Area	F7.0
43-49	External Cowl Angle (deg)	F7.0
50-56	Exit Nozzle Type for Bleed	F7.0
57-63	Exit Nozzle Angle for Bleed (deg)	F7.0
64-70	Exit Flap Aspect Ratio for Bleed	F7.0
Card 2		
Cols.		
1-7	Exit Flap Area for Bleed	F7.0
8-14	Exit Nozzle Type for Eypass	F7.0
15-21	Exit Nozzie Angle for Bypass (deg)	F7.0
22-28	Exit Flap Aspect Ratio for Bypass	F7.0
29-35	Exit Flap Area for Bypass	F7.0
36-42	Subsonic Diffuser Area Ratio	F7.0
43-49	Subsonic Diffuser Total Wall Angle (deg)	F7.0
50-56	Subsonic Diffuser Loss Coefficient	F7.0
57-63	Throat to Capture Area Ratio(PITOT)	F7.0

4.2.1.1.3 Non-changeable Inlet Parameters

The non-changeable parameters provide information about the basic design ground rules of the mapped configuration.

Card 1 Cols.	Parameter Definition	Format
1-7	Geometry Type	F7.0
	<pre>0. = axisymmetric inlet</pre>	1710
	1. = 2-D inlet	
	2 PITOT inlet	
8-14	Nominal Normal Shock Mach Number	F7.0
15-21	Starting Mach Number	F7.0
22-28	Nominal Throat Mach Number	F7.0

4.2.1.1.4 Inlet Tables

The inlet map file consists of 14 tables. The tables are input in sequential order and are listed below. More detail about the use of these tables can be found in the PIPSI Users Manual, Volume II.

Table 1

A Type 1 table of Local Mach Number versus Freestream Mach Number

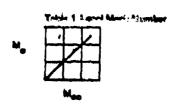


Table 2A

A Type 3 table of Recovery versus Mass Flow and Local Mach Number

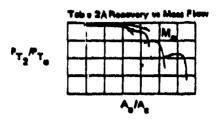


Table 2B

A Type 1 table of Matched Inlet Recovery versus Local Mach Number

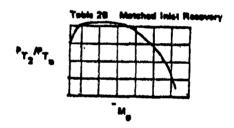


Table 20

A Type 1 table of Matched Mass Flow versus Local Mach Number

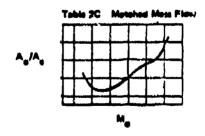


Table 2D

A Type 1 table of Buzz Limit versus Local Mach Number

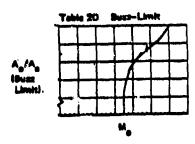


Table 2E

A Type 1 table of Distortion Limit versus Local Mach Number

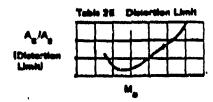


Table 3

A Type 3 table of Spillage Drag versus Inlet Supply ratio and Local Mach number

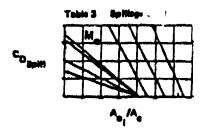


Table 3A

A Type 1 table of Reference Spillage Drag versus Local Mach Number



Table 3B

A Type 1 table of Reference Mass Flow versus Local Mach Number

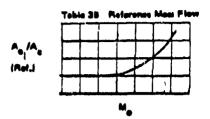


Table 4

A Type 2 table of Boundary Layer Bleed Drag versus Bleed Supply ratio and Local Mach Number

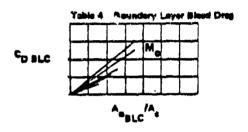


Table 5

A Type 2 table of Bypass Drag versus Bypass Supply ratio and Local Mach Number

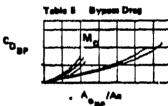


Table 6A

A Type 3 table of Bleed Supply ratio versus Ao/Ac and Local Mach Number

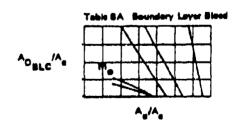


Table 6B

A Type 1 table of Matched Boundary Layer Bleed ratio versus Local Mach

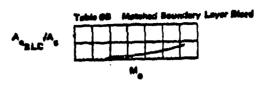


Table 7

A Type 3 table of Bypass ratio versus Engine Supply ratio and Local Mach Number

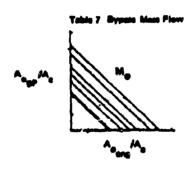
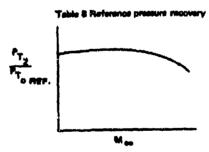


Table 8

This is an <u>optional</u> type I table of reference recovery factor versus free stream Mach number.



The derivative procedure program does not perform any operations on this table. It just transfers it along to the TAPE1 output file for PIPSI usage.

4.2.1.2 Afterbody file (TAPE 52)

This disk file consists of five separate sections

- (1) Afterbody Title Card
- (2) Afterbody Derivative Parameters
- (3) Afterbody Location versus Area Curves
- (4) Non-changeable Afterbody Parameters
- (5) Afterbody Drag Table

Figure 7 is an example of a typical afterbody file.

4.2.1.2.1 Afterbody Title Card

An 80-character title card must be the first card of the afterbody file. It is read with an A format and is printed as a heading on the output data.

4.2.1.2.2 Afterbody Derivative Parameters

The afterbody derivative parameters provide the basic information describing the configuration in terms of its important parameters. These data are used by the derivative program as a starting point from which a new configuration performance is derived.

Card 1	Parameter Definition	<u>Format</u>
Cols.		
1-7	Nozzle Static Pressure Ratio	F7.0
8-14	Tail Fin Configurations (0., 1. or 2)	F7.0
15-21	Tail Fin Angle (deg)	F7.0
22-28	Tail Fin Fore-and-Aft Location Ratio	F7.0
29-35	Base Area Ratio	F7.0

4.2.1.2.3 Afterbody Location Versus Area Curves

The area curves are used to calculate the IMS $_T$ parameter which is the basic afterbody drag correlation parameter. For each A10/A9 curve in the C_D table, there corresponds a nozzle aftbody area versus location distribution.

CD 2R	INPUT MA	AP.					
		0.					•
		7.					
		760.				676.	
		36					-
		760.					
		36.		_	_		
		76A					
		36.					
		760.				_	
		- 36					
		760.			_		
		36.					
	AB8.						
		3.33	F	7.43			
		1-13				2.0	2.3
		.096					
		•107					- 048
		138		_			
						.066	
		•1 <i>E</i>					
.083	• 08 3	•226	• Z V	• 146	.122	.160	- 090

Figure 7. Afterbody File Example

Card 1 Cols.		Format
1-7	Number of Curves	F7.0
Card 2	Number of Points/Curve	Format
Cols.		
1-7	No. Points for Curve 1	F7.0
8-14	No. Points for Curve 2	F7.0
•	•	•
•	•	•
•	•	•
64-70	No. Points for Curve 10	F7.0
Card 3	Curve 1 Location Values (in)	Format
1-7	v	
	^X 1	F7.0
8-14	x ₂	F7.0
•	•	•
•	•	•
·	•	•
64-70	x ₁₀	F7.0
Card 4 Cols.	Curve 2 Area Values (Sq. Ft.)	
1-7	Δ.	F7.0
8-14	A ₁	F7.0
	A ₂	
•	•	•
-	•	•
• 64-70	Δ	F7.0
	"10 of the Area Paties in C Teble	F/.U
acc. For the rest	of the Area Ratios in C _D Table	

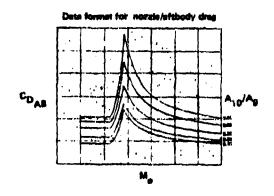
4.2.1.2.4 Non-changeable Afterbody Parameters

The non-changeable afterbody parameters provide additional basic information describing the configuration and its important parameters.

Card 1	Other Parameters	Format
Cols.		
1-7	Geometry Type	F7.0
	O. axisymmetric	
	1. 2-D	
8-14	Afterbody Type	F7.0
	1 CD Axisymmetric Single Nozzle	
	2. = CD Axisymmetric Dual Nozzle	
	3 CD 2-D Single Nozzle	
	4. = CD 2-D Dual Nozzle	
	5 Plug Axisymmetric Single Nozzle	
	6 Plug Axisymmetric Dual Nozzle	
	7 Wedge 2-D Single Nozzle	
	8. = Wedge 2-D Dual Nozzle	

4.2.1.2.5 Afterbody Drag Table

The afterbody drag table is a Type 2 table of Afterbody Drag versus AlO/A9 and local Mach Number



The same table format is used for both round and two-dimensional nozzles; however, the afterbody drag coefficient in the input table for the two-dimensional nozzle is defined differently from that for the round nozzle input. These coefficients are defined as follows:

For Round Nozzle:

$$c_{DAB} = \frac{D_{AB}}{q_0 A_{10}}$$

For Two-Dimensional Nozzle:

$$c_{DAB} = \frac{D_{AB}}{q_{o}(A_{10} - A_{o})}$$

The definitions for the two nozzle/aftbody drag coefficients are different because the experimental data for the two-dimensional nozzle as obtained were nearly all based on the projected aftbody area, $(A_{10}-A_{9})$, rather than the cross-sectional reference area, A_{10} , as was the case for the round nozzle. Therefore, for two-dimensional nozzles, the input drag coefficient was defined as shown above to make the most direct use of the available experimental data.

The derivative procedure program processes the calculations of new inlet, afterbody drag, and nozzle internal performance using separate files of input data and separate procedures in the computer code. It is possible, therefore, to run any combination of inlet, nozzle/aftbody, and nozzle configurations during execution of the program. The results of the program calculations are stored on output TAPE1. The user must then split off the results into files that are used as input to PIPSI.

- 4.2.1.3 Nozzle Thrust Coefficient File (TAPE 53)
 This disk file consists of four separate sections
 - (1) Nozzle Title Card
 - (2) Derivative Parameters
 - (3) Non-changeable Nozzle Parameters
 - (4) Nozzle Thrust Coefficient Table

Figure 8 is an example of a typical nozzle thrust coefficient file.

D.	D.	D.	11.45						
	1	1 '	11075						
TABLE		0 7•	·						
•	-	• •					•		
1.	1.1		1.3						
1.5	2_0	3-0		5-0	6.5		1.0] 4	18
.992	.992	.986			.955	-938	. 924	.903	.866
.932	965	.984	. 986	-982	.975	-960	.947	.925	.908
-888-	935	577	986	· 9.88·	563	975	558	938 -	92
. 5 6 2	905				•982	. 572	. 964		. 532
-840	-85	.942	.970	•983	.986	.576	. 968	. 554	.942
	2.7.6		962	977	689	49.7%_	970	955	948
. B	-867	.922	.952	.97		.978	.972	.961	-952

Figure 8. Nozzle Thrust Coefficient File Example

4.2.1.3.1 Nozzle Title Card

An 80 character title card must be the first card of the nozzle file. It is read with an A format and is printed as a heading on the output data.

4.2.1.3.2 Derivative Parameters

The nozzle/aftbody derivative parameters provide the basic information describing the configuration in terms of its important parameters. These data are used by the derivative program as a starting point from which a new configuration performance is derived.

Card 1	Parameter Definition	Format
Cols.		
1-7	Plug Half Angle (deg)	F7.0
8-14	Wedge Half Angle (deg)	F7.0
15-21	Aspect Ratio	F7.0
22-28	Divergence Half Angle (deg)	F7.0

4.2.1.3.3 Non-changeable Nozzle Parameters

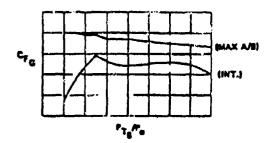
The non-changeable parameters provide information describing the configuration in terms of-important basic parameters that were used to derive the performance maps. They describe the configuration but are not used in the interactive sessions.

Card 1	Parameter Definition	Format
Cols.		
1-7	Nozzle Type	F7.0
	<pre>1 = Round Convergent-Divergent</pre>	
	2 = 2-D Wedge	
	3 = Round Plug	
	4 = 2-D Convergent-Divergent	

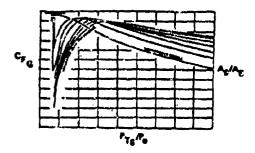
4.2.1.3.4 Nozzle Thrust Coefficient Table

The format of the table varies depending on whether the user has selected a round or 2-dimensional nozzle.

For a 2-dimensional nozzle the table is a Type 2 table of nozzle thrust coefficient versus $P_{\mbox{T}_{\mbox{R}}}/P_{\mbox{O}}$ and PS.



For a round nozzle the table is a Type 2 table of nozzle thrust coefficient versus A_S/A_8 and $P_{T_{\Omega}}/P_o$



4.2.2 Output Disk Files

The user selects the output options through responses to prompts while executing the derivative procedure program interactively. There are three disk files used for output:

- TAPE 6 for printed output
- TAPE 1 for new PIPSI file

4.2.2.1 TAPE 6 Output

The output on TAPE 6 is always obtained when the derivative procedure is executed. It contains a listing of the old maps and derivative parameters and a listing of the resulting new maps and derivative parameters. If a hard copy of the results is needed, the file can be disposed for off-line printing. An example of this output is given in Figure 9.

4,2.2.2 TAPE 1 Output

The TAPE1 (new PIPSI file) is formatted exactly like the input disk file (either TAPE 51, TAPE 52, or TAPE 53, whichever was used as input; see Figures 6, 7, and 8). This file is generated only if the user wishes to run the PIPSI program and perform an execution. If the user uses this file to run DERIVP, a message will appear at the terminal, indicating to the user that the input was from a previous derivative procedure execution and the program will abort.

4.3 Interactive Input

In order to execute the derivative procedure program, the user must provide interactive inputs via a terminal. Figure 10 shows an example of typical terminal session.

The terminal prompts and a typical set of user responses are enumerated as follows:

4.3.1 Map Type Code

The user may input either

- 1) for inlet map file (TAPE 51)
- 2) for afterbody drag file (TAPE 52)
- 3) for nozzle thrust coefficient file (TAPE 53)

The option selected means that the user must have previously attached that particular file.

		****			OLD	INCEY	MAP	3	
		274	Z INLET	MAP					
					LOCA	L HACH I	NUMBER	······································	
ARGE1		OF POX	NTS =	3.	سيكي مساسي				
0.000	.200	2.000							
						VERY VS			
					~===	VER! V3	nmaa ri		
ABCEZA UMBER G	F X POI	OF Y P	UINTS *	6.	• 7.	7.		9.	
.950	.700	. 650	1.200	1.600	2.000				
-700	-800	. 900	-1:000	.950	1.075	1.100			
.600	.991 .700	.985 .800	.969 .909	,950	.933 .970	. 875			
-990		.485		.045					
-500	.600	.700	.000	. 8 50	.875	.905			
.990	.990	.989	. 9 83	. 975	.962	.900			
-300	. 600	• 100	.800	. 120	. 879	.405			
.980	.979	.977	oP73	. 667	. 955	. 900			
•500 •978	.600	.700	.800	.850	.875 	.885	.890 .900		
.500	.600	.700	.800	.900	.930	.935	.943	.950	
.958	.953	. 949	.944	.935	.925	.920	.900	.850	
				_	HATC	HED INL	ET RECOV	VERY	
ABLEZB	- 200	OF POI	-800 MIZ =	- 1900 4.	1.000	1.200	1.600	2.000	
.900	.950	.065	.972	.975	.975	-967	.948	.925	
······································					HATS	HED HAS	S FLOW	<u>, , </u>	
ABLEZE	NU4 BER	OF POI	NTS .	7.				— — — — — — — — — — — — — — — — — — — 	
.400	.600	.000	1.000	1.200	1.600	2.000			
1.310	1998	.863	.830	-840	-012	CIP		سعد م جندهایه بنگیم د	
	······································				BUZZ	стит			
ABLEZU	NUTBER	וניש אם	NYS -	5.					
0.000	1.399	1.400	1.600	1.800	2.000				
0.000	0.000	.400	.500	. 560	-600				

Figure 9. Example of TAPE6 Output

					013	CURTION	LINIT.				
TABLEZE		OF POI		6.							
.550	.700	.800	1.200		2,000						
1.055	.935	-890	.846	.840	. 735						
				۔۔ بہت ۔۔۔	3776	LAGE DR	AG			,	· • • • • • • • • • • • • • • • • • • •
PABLES	NUMBER	OF Y P	UINIS =					· · · · · · · · · · · · · · · · · · ·			
NUMBER 0	F X POI	NTS =	2.	z.	7.	9.	9.	9.	7.	7.	7.
0.000	.549	.950	.700	. 9 30	1.200	1.400	1.600	2.000			
0.000	1.000										
0.000	0.000										
0.000	1.000										
.300	4400	.,500	.600	.700	.715	1.000					
.185	.110	.052	.015	.002	0.000	0.000					
•300	- 400	•500	-600	.700		-960	. 950	1.000			
.310	.207	.123	.062	.032	.015	.005	0.000	0.000			
.300	.400	.500	.600	.700	. 800	. 900	, 963	1.000			
6410	.280	.175	.098	.030	. 320	-010		0.000			
.300	.400	.500	.600	. 700	u #00	.900	. 958	1.000			
.300	.360	.240	.150	.086	.038	-014	0.000	0.000			
-300	.300	.700	.800	.887	-404	1.000					
.750	.437	.210	.110	• 022	0.000	0.000					
.500	.600	.700	. 800	. 415	. 92 0	1.000					
•713	•330	.370	.210	1057	0.000	0.000					
.500	.700	.800	.900	.957	. 962	1.000					
.840	.480	.298	.118	.010	0.000	0.000		·			 -
			·		REFE	RENCE S	PILLAGE	DRAG		-	······································
TABLESA	HUMBER	OF POI	HTS =	. 3.							
0.000	0.000	0.000									
					REFE	RENCE P	ASS FLO	W			
TABLESS	NUMBER	OF PO1	NTS .	3.							
0.000	1.000	2.000									
1.000	1.000	1.000									
			· · · · · · · · · · · · · · · · · · ·		EGUN	IUAKY "L'	YER BLE	ED DRAG			
TABLES		<u>UF </u>	MT 11 - C + -			.	PUINTS	,			
0.700	.849	.850	1.200	1.700	2.000	in ur im	-E-0 1 11 3 4		•		
0.000	.010	.020	.040	.060							
0.000	0.000	0.000	0.000	0.000					****		
0.000	0.000	0.000	0.000	0.000							
0.000	.007	.014	.028	.042							
0.000	.010	.021	.042	.062		· ····································					
0.000	.011	-022	.044	.066							
0.000	.013	-026	.052	.078							

Figure 9. Example of TAPE6 Output (continued)

					BYPA	SS DRAG	}			
ABLES	NUMBER	DF X-P	OINTS=	7.	NUMBE	R 05 Y-	PDINTS-	8.		
0.000	. 9 4 9	.850	1.000	1.200	1.400	1.700	2.200			
0.000	-040	.080	*150	.180	. 200	.240				
0.000	0.000	0.000	0.000	0.000	0.000	0.000				
0.000	0.000	0.000	0.000	0.000	0.000	0.000				
0.000	.062	•125	-148	.580	.300	.500				
0.000	.050	.100	.156	.217	290	.375				
0.000	.036	.075	.117	.162	.220	.290				
0.000	.030	.052	.0 81	133	.185	-241				
0.000	.020	.052	.074	.116	.160 .153	.216 .210				
	.020	1043	1077		* 1.73			·		_
					BOUN	DARY LA	YER BLEE!	DRAG		·
	P X PUL	NTS B	OINTS -	7.		5.	3.	6.	6.	6.
0.000	.900 1.000	1.000	1.200	1.400	1.600	1.800	2.000			
0.000	0.000									
0.000	1.000									
0.000	0.300									
		.631	.900	1.000						
.008	.007	.005	.003	0.000						
.600	700	.840	.900	1.000						
1014	.013	.010	.008	0.000		·····				
.600	.700	.859	.900	1.000						
.022	.020	.015	.012	0.000						
.600	- 700	- 200	.001	.430	1.000					
.030	.029	.026	•050	.014	0.000					
.600	.700	.800	.906	. 930	1.000					
- 044	-0.45	-037	.025	.021	0.000			.,		وكبيوا مستسب ببدور
-400	.700	.000	.900	. 930	1.000					
	.056	.050	.017	.030	0.000					
.050										
					MATO	HED 800	INDARY LA	rer slee	D	
.050		0F P01	INTS .	5.	MATO	HED BOU	INDARY LA	TER BLEE	D	**************************************
		1.200	NT\$ =	5. 2.000	MATO	HED SQU	INDARY LA	rer Blee	D	

Figure 9. Example of TAPE6 Output (continued)

					BYPA:	SS HASS	FLOW		
TABLE7			OINTS -					,	
C FERMU			2.	Z.	4.	4,	4.	4.	
0.000		1.400	1.600	1.400	2.000				
0.000	1.000								
0.000	1.000								
0.000	0.000								
.400	.854	.859	1.000						
.481	-005		0.000						
								المحالفة المستحدة ويتواثقه والطويقة عن سميد	
.400	.672	.002	1.000						
-483	.010	0.000	0.000						
.400	.892	.906	1.000						
.506	014	0.000	0.000						
.400	.915	.930	1.000						
.532	.015	0.000	0.000						
		INL				PARAMET			
PANAMETE	K NOUBE	Į,	,	ARAPETE	K DEFIN	LTION		OFD AYFOR	
1		ASPEC	T RATIO					1.0000	
-			LATE CU		······································			.2000	
3			RAMP A		G)			7.3000	
4			IN HACH					2.0000	
			LIP (LU					.0200	
6			OFF 000					.2000	
7			HAL COM					17.3000	
					KALEED			1.0000	
9					OR BLEE!			15.0000	
10			FLAP AX		TID FOR	ALESU		2.0000	
12					R.BYPAS	•		1.0000	
13					OR BYPA:			15.0000	
					TEO FOR			2.0000	
is			FLAP AR			J		.2000	
16					REA RAT	to		1.5000	
						LANGLE	(DEC)	10.0000	
1 0		20820	INIC DIF	FUSER L	OSS COE	FFICIENT		.1000	
		Figure	9. E	xample	of TAP	E6 Outp	ut (co	ntinued)	

					NEW	INLEY	HA	3	
		ATS	2 INLET	HAP					
					LOCA	L MACH I	NUMBER		
ABLE1 0.000	NUMBER .200	OF POT	NTS -	3.					
0.000	.200	2.100			· · · · · · · · · · · · · · · · · · ·				
		· · · · · · · · · · · · · · · · · · ·	······································	+	KECU	VERY VS	HASS F	COW	
					_				
UMAFR O	F X POI		UIMIS # 7.	6.	7.	7.	8.	9.	
.550	.700	.850	1.220	1.660	2.100			,,	
.00/	762	.837	. 433	1.009	1.024	1.048			
.992	.991	. 985	.969	. 950	.933	.875			
.572	.667	.762	. 8 5 7	. 905	.924				
.476	.571	.667		.010	.000	.862			
.990	.990	.989	.76Z .983	.975	.962	.900			
481	- 378	.676	771		1.843				
.979	978	.976	972	. 966	.954	.899			
490	.589	-687	.786	. 835	.859	869	.574		
- 172	.966	-061	974	751	. 936	.921	876		
499	.599	.700	800	. 900	. 930	.935	.943	.950	
.950	. 945	.941	.936	.927	.917	.912	.892	.842	
					HATC	HED INL	ET RECD	VERY	
ABLEZB		OF POI		9.					
.900	.950	. 965	.6 00 .9 72	.975	.975	.966	.944	.917	
					HATC	HED MAS	5 FLOW		
ABLEZO	NUMBER	OF POI	NTS -	7.					
.400	.600	.800	1.000	1.220	1.660	2,100			
1.248	. 455	.622	.790	.809	-857	*414		**************************************	
·		····			BUZZ	LIMIT		·	
7-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1		» بدر الد . مجاهد .							
0.000	1.439	1.440	1.660	1.880	2.100				
0.000	0.000	.869	1.000	.874	.874				

Figure 9. Example of TAPE6 Output (continued)

*************					OISY	DRTION	LIMIT				
TABLEZE	NUM B ER	OF POI	NTS =	6.							
.550	7.00	.000	1-220	1.660	2.100						
•337	• 572	.476	. 481	.490	. 599	-		-			
	1 - u - u - u - u - u				ZPIC	LAGE DR	A 6	The same of the sa			
· · · · · · · · · · · · · · · · · · ·						 					
MUMBER O			UINTS =	2.	7.	ο.			-	-	7.
0.000	.549	.550	.700	. 850	1.220	1.440	1.660	9. 2.100	7.	. 7.	•
0.000	1.000										
0.000	0.000										
0.000	1.000										
0.000	0.000							·			
.286	381	.476	.572	.667	.681	1.000					
.151	.107	.050	.014	.002	0.000	0.000					
.286	.301	.476	.572	. 667	.762	.857	705	7.000			
-304	.202	.119	.059	.030	.012	.005	0.000	0.000			
.286	. 381	.476	5 72 ه	.667	. 762	.857	.917	1.000			
•402	.273	.170	.094	-047	-021	.043	0.000				
.299	.386	.482	.578	. 675	.77%	.868	.924	1.000			
.227	.146	.084	.043	.019	.006	.001	0.000	0.000			
-545	.487	* 241		-864	. 699	1.000					·
.796	. 447	.220	.115	.025	0.000	0.000					
.492	. 5 90	.688	.786	. 900	.912	1.000					
733	200	*300	.223	.057	4-000	-0.000					
-500	.701	.801	.901	. 958	• 963	1.000					
.862	.499	.312	-125	.010	0.000	0.000					
					REFE	RENCE S	PILLAGE	DRAG			<u> </u>
TABLESA	MIIMBCB	ወደ ቀባ፤	UT	3.							
0.000	1.000	2.100	~ -								
0.000	0.000	0.000									
					REFE	RENCE H	ASS FLO	W			ir May dans
TABLESE		AC 55'	MYC -								
0.000	1.000	0f POI 2.100	n12 =	3.							
1.000	1.000	1.000									
1.000	*****	11000									
,,			and the factoring of the control for the		BOUN	DARY LA	YER BLE	EU DRAG			سح
TABLES	TURBER	- 07 - 70 - 1 0 - 10 - 10 - 10 - 10 - 10 - 10 - 10 -	UINTS=	7.	NUMBE	K 0k 4a	PUINTS				 .
0.000	.849	.850	1.220	1.770	2.100						
0.000	.010	-020	.041	.061							
0.000	0.000	0.000	0.000	0.000							
0.000	0.000	0.000	0.000	0.000							
0.000	.007	-014	.028	. 0 42							
0.000	.010	120	.042	.062			 				
0.000	.011	.022	.044	.066							
0.000	.012	-025	.050	.075							

Figure 9. Example of TAPE6 Output (continued)

					SYPA	SS DRAG				
TABLES		OF X-P		7.			POINTS	8.		
0.000	.849	.850	1.000	1.220	1.440	1.770	2.320			
0.000	0.000	0-000	0.000	0.000	0.000	0.000				
0.000	0.000	0.000	0.000	0.000	0.000	0.000				
0.000	2000	.123	1,70	.280	-300	. 300				
0.000	.050	.100	.156	.217	.290	.375				
0.000	.036	•075	.117	-162	. 220	.290				
0.000	.025	-052	.047 \$80.	.137	-160	-216				
0.000	.021	.046	.076	.113	.157	.215				
					BOUN	DARY LA	YER BLEE	DRAG		
TABLESA	MUHRER	GE Y E	POINTS -		1 _m					
NUMBER O					7.	7.	7.	6,	6.	6.
0.000	00			1.440		1.000	2.100	•		
000	. 953	- درود مکنی پسیونی			-					
000	.953									
0.000	0.000									
.774	670	.795	.861	. 457-						
-008	.007	.005	.003	0.000						
.578	.674	.809	.867	. 964						
-014	:013	.010	.008	0.000						
.5#3 .022	.020	.015	.876 .012	. 973 0. 000						
- 284	- 687	.768			. 783					
.031	.030	.027	.020	014	0.000					
.594	.693	.793	. 4 98	. 922	. 992					
1047	.043	.010	.020	120.	0.000					
.5 49 .061	.700	.800	.900	.930 -031	1.001					
									_	
					MATC	HED BOU	NOARY LAY	ER BLEE	<u> </u>	
TABLE IIB		OF POI	NT3 +	5. 2.100						
0.000	0.000	.010	-020	.031						
					BYPA	35 HASS	PLOW	· · · · · · · · · · · · · · · · · · ·		
TABLET NUMBER 1	F X POI	NTS -	OINTS .	2.	4.	4.	4.	4.		
0.000	1.000	1.440	1.680	1.080	2.100					
0.000	0.000									
0.000	1.000	,			····					
0.000	c.000									
.384	. 831	.836	1.000							
-,444	.009	0.000	0.000							
.475	-857	0.000	1.000							
.398	.010	.900	1.000							
.,,,,,	-014	0.000	0.000				···			
.402	.414	.934	1.000							
.534	.015	0.000	0.000							

Figure 9. Example of TAPE6 Chitput (continued)

	INLET HAP DERIVATIVE PARAMETERS	
PARAMETER NUMBER	PARAMETER DEFINITION	NEW VALUE
1	ASPECT RATIO	1.0000
7	SIDENTATE CUIBACK	.2000
3	FIRST RAMP ANGLE (DEG)	7.1000
4	DESIGN MACH NUMBER	2.1000
7	COMP FIR SEGMINE 22	• 0200
6	TAKE OFF DOOR AREA	. 2000
7	EXTERNAL COWL ANGLE(DEG)	17.5000
	EXIT HOZZLE TYPE FOR BLEED	1.0000
9	EXIT HOZZLE ANGLE FOR BLEED(DEG)	15.0000
10	EXIT FLAP ASPECT RATIO FOR BLEED	2.0000
11	EXIT FLAP AREA FOR BLEED	.1000
12	EXIT NOZZLE TYPE FOR BYPASS	1.0000
13	EXIT MUZZLE ANGLE FOR BYPASS(DEG)	15.0000
15	EXIT FLAP AREA FOR BYPASS	2.0000
16	SUBSONIC DIFFUSER AREA RATIO	.2000 1.7000
	SUBSUNIC DIFFUSER YOTAL WALL ANGLEIDEG!	
19	SUBSONIC DIFFUSER LOSS COEFFICIENT	.1417
• **	10030410 DIFFORE EDSS COCFFICIENT	14741
		the control of the co
		Annuagues sugar
		rinselle del les mentils délisées consequentes de généralements « qu'est résidéntés délisées resque « voules a
		The state of the s
principal principal company and principal consequences and appropriate of the second s		Skilleden bereiter von der eine Planskeren bestellt zugelich ergen zustalle bestellt der einer
	a designation where the second construction of the second	and control was the state one and the control of the state of the stat

Figure 9. Example of TAPE6 Output (continued)

				OLD	AFTER	BODY MA	PS		
	ct	38 - I NRUI	MAP						
				AFTE	REODY D	RAG TAB	LE		
7 A B L E A B	NUMBER OF X-			NURBEI	OF Y~	POINTS=	· · · · · · · · · · · · · · · · · · ·) <u>a</u>	
-400	.900 1.130				2.000				
-037	-037 -096		.065 	-045	-045	-042			
.064	.064 .138		.094	.081	. 066	.060			
.075	.075 .180		.120	.103	.085	- 377			
				133					

ANAMETE	R NUMBER	۶	ARAMETE	R DEFINI	HION		OFD A	LUE	
	NOZZ	LE STATE	C-PRESS	URE RAT				-0000	
2		FIN COM	-	-				-0000	
3		FIN AND				***		1734	
5		AREA RA		Landard All Control		4-6-6		.0000	
HE ROLL	OHING ARE THE	TABLES	OF STAT	TONETHE	VE B SIIC	ADFAIS	OFTI		
			• • • • • • • • • • • • • • • • • • • •	. • • • • • • • • • • • • • • • • • • •	15.000	2116210			
									
	TABLE NUMBER			A10/A9 .		18			
				AND ARE					
	44.50 700.00 20.50 876.00		60.00	36-00 80	10.00	31.00 8	50.00	25.00	
									
	TABLE NUMBER	= 2		A10/A9 =		50			
	AA.50.700.00	A1 80 7		AND ARE		11.5n s	28 06	28 00	
					. * * * * * * * * * * * * * * * * * * *		****	-4444	
	SAFOR BIBERS								
30.00									
30.00	TABLE NUMBER			A10/AD 7		دد			
30.00	TABLE NUMBER	- 1	STATION	AND ARE	:A		20-00	25.00	
430.00 437.00		42.50 7	STATION 60.00	AND ARE	:A		20.00	25.00	
430.00 437.00	TABLE NUMBER 44.50 700.00 20.80 874-00	42.50 7	STATION 60.00	AND ARE	A 00.00	31.00 8	20.00	25.00	
430.00 437.00	TABLE NUMBER	42.50 7	STATION 60.00	AND ARE 36.00 80	A 00.00		20.00	25.00	
437.GO	TABLE NUMBER 44.50 700.00 20.80 874-00	42.50 7 13.34	STATION	AND ARE	A 10.00	31.00 8			
637.00 637.00	TABLE NUMBER 44.50 700.00 20.50 876-00 TABLE NUMBER	42.50 7 13.34	STATION	AND ARE 36.00 80 A10/A4 #	A 10.00	31.00 8			
637.GO	TABLE NUMBER 44.50 700.00 26.50 676.00 TABLE NUMBER 44.50 700.00 20.50 876.00	42.50 7 13.34 = 4 41.50 7 8.92	STATION 60.00 STATION 60.00	AND ARE 36.00 80 Alb/A9 # AND ARE 36.00 80	5. 10.00	31.00 8 90 31.00 8			
637.GO	TABLE NUMBER 44.50 700.00 TABLE NUMBER	42.50 7 13.34 = 4 41.50 7 8.92	STATION STATION	AND ARE 36.00 80 A10/A4 #	5. 10.00	31.00 8			

Figure 9. Example of TAPE6 Output (continued)

					NEW	AFTER	BODY MAPS		
			R INPU	L-MAR			·		
					AFTE	REODY D	RAS TABLE		
TABLEAS			OINTS=	8. -7.410	NUMBE	R OF Y	POINTS=	5.	
.400	.900	1.130	1.200	1.400	1.600	2.000	2-300		
.093	•093	-153	.132	-100	- 683	.066	.059		
.120	.120	.195	-170	.129	.107	.087	.077		
.131	-131	-237	-206	-155	-131	-106	. D94		
	-103		487			558			
					AFTE	RECOY D	RAG-CORRE	CT 10N	
	MUMBER	OF Y	DINTE	N. MAL		-Y-POIN	T&_= 5	MUMBER-OR-2 PC	STATE -4. 4
							-		
2-180	3.930	5-649	7.430				-		
2.180 .400	3.930	5-689 1-350	7.430 1.825	2.300					
.400 -800 -105	3.930 .875 1.000	5-689 1-350 1-500 105	7.430 1.825 2.000 210	2.300 3.000 420					
-486 -800 -105 -114	3.930 .875 1.000 0.000	5.689 1.350 1.500 105 114	7.430 1.825 2.005 210 227	2-300 3-000 420 455					
-486 -800 -105 -114	3.930 -875 1.000 0.000 0.000	5.689 1.350 1.500 105 114	7.430 1.825 2.005 210 227 137	2.300 3.000 420					
.400 .105 .114 .068 .015	3.930 -875 1.000 0.000 0.000 000	5-689 1-350 1-500 105 114 015 002	7.430 1.825 2.008 210 227 137 030 004	2.300 3.000 420 455 274 061 009					
.400 .105 .114 .068 .015 .002	3.930 -875 1.000 0.000 0.000 000	5-689 1-350 1-500 105 114 015 002	7.430 1.825 2.005 210 227 137	2.300 3.000 420 455 274 061 009					
.400 .105 .114 .068 .015 .002 .039	3.930 .875 1.000 0.000 0.000 000 0.000 0.000	5-689 1-350 1-500 105 114 015 015 035 039 023	7.438 1.825 2.008 210 227 338 004 077 047	2.300 420 455 274 061 155 155					
.400 .105 .114 .068 .015 .002 .039 .023	3.930 .875 1.000 0.000 0.000 000 0.000 0.000 0.000	5-689 1-350 1-500 105 114 015 002 039 023	7.438 1.825 2.008 210 227 038 004 077 047	2.300 420 425 274 061 007 155 193					
.400 .105 .114 .068 .015 .002 .039 .023 .023	3.930 .875 1.000 0.000 0.000 000 0.000 0.000 0.000 0.000	5.689 1.350 1.500 105 015 002 039 023 023	7.430 1.825 2.000 210 227 030 004 077 047 047	2.300 420 425 274 061 007 155 093 093					
.400 .105 .114 .068 .015 .002 .039 .023	3.930 -875 1.000 0.000 0.000 000 0.000 0.000 0.000 0.000 0.000	5.68 P 1.350 105 114 015 002 039 023 023 024 024	7.430 1.825 2.088 210 227 030 004 077 047 001 001	2.300 3.000 420 455 274 061 095 155 093 093 093					
.400 .500 .105 .114 .068 .015 .002 .039 .023 .008 .001	3.930 -875 1.000 0.000 0.000 000 0.000 0.000 0.000 0.000 0.000 0.000	5.68 P 1.350 105 114 015 002 039 023 005 001 004 005 004	7.430 1.825 2.008 210 227 030 004 077 047 001 001 001	2.300 3.000 420 425 274 061 009 155 093 093 093 094 063					
.400 .105 .114 .015 .015 .002 .039 .023 .001 .024 .024	3.930 .875 1.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000	5.68 P 1.350 105 114 015 002 039 023 024 024 016 003	7.430 1.825 2.008 210 227 030 004 077 047 047 001 001 048 031 007	2.300 420 425 274 061 009 163 093 093 093 093 093 093					
.400 .105 .114 .015 .015 .002 .039 .023 .001 .024 .024	3.930 .875 1.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.00000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.	5.68 P 1.350 105 114 015 015 023 039 023 024 016 016 024	7.430 1.825 2.08 210 227 030 004 077 047 047 091 091 001 001 001 001	2.300 3.000 420 455 27A 061 093 093 093 094 063 064 063 095					
.400 .105 .105 .015 .002 .039 .023 .001 .024 .003	3.930 -875 1.000 0.000 0.000 000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	5.68 P 1.350105114015025039023025016024024026	7.430 1.825 2.088 210 227 030 004 077 047 091 091 007 007 007	2.300 420 455 274 061 095 095 095 095 095 014 095 095					
.400 .500 .105 .114 .015 .002 .039 .023 .001 .024 .036 .016 .003	3.930 -875 1.000 0.000 0.000 000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	5.68 P 1.350 105 114 015 015 023 039 023 024 016 016 024	7.430 1.825 2.088 210 227 030 004 077 047 001 001 004 001 001 001 001 001	2.300 3.000 420 455 27A 061 093 093 093 094 063 064 063 095					
.400 .500 .105 .114 .005 .015 .002 .036 .001 .024 .003 .005 .003 .005 .005	3.930 -875 1.000 0.000 0.000 000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	5.68 P 1.350105114015025023023024016003026026026	7.430 1.825 2.008 210 227 030 004 077 047 001 001 001 001 007 007	2.300 420 425 274 061 009 155 093 093 093 094 043 043 095 095 095					
.400 .500 .105 .114 .015 .002 .036 .035 .001 .024 .025 .003 .005 .024 .024 .025 .003	3.930 -875 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	5.68 p 1.350105114015015023023024026026026026026026026	7.430 1.825 2.08 210 227 030 004 077 047 047 091 001 001 001 001 001 001	2.300 3.000 420 425 27A 061 093 093 093 093 014 063 014 095 014 014	TO OFFI	PARANE	TERS	IEU-MALUE	
-400 -500 -105 -114 -068 -015 -002 -036 -001 -024 -035 -016 -003 -024 -025 -018 -003 -003	3.930 -875 1.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.0000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.000 0.000 0.000	5.68 P 1.350 1.500114015015023023024026026026026026026026026026026026026026026026	7.430 1.825 2.08 210 227 030 004 077 047 091 001 001 001 001 001 001 007	2.300 3.000 420 425 27A 061 007 155 093 093 003	LIVATIVE TA DEFIN	PARANE	TERS	1.0000	
.400 .500 .105 .114 .015 .002 .039 .023 .001 .024 .003 .003 .005 .003 .005 .005 .005	3.930 -875 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	5.68 p 1.350105114002036039023024026026026026026026026026026027027031	7.430 1.825 2.001 2.007227030007047047047051007001048051007001048051007051007051007051007	2.300 3.000 420 425 27A 061 093 093 093 093 014 063 014 095 014 014	LIVATIVE TA DEFIN	PARARE	TERS	IEU-MALUE	

Figure 9. Example of TAPE6 Output (continued)

IHE-FOL		<u>-i.r.c</u> 745	TABLE	7-05-51	118011	M) VERI	JUS-AREA	.4 50FT)		
		NUMBER	_	STATIO	A10/A	AREA	2.18			
		700.00 876-80		760.00	36-00	#00.00	31.00	-130-00	25.00	
	TABLE	NUMBER			410/4	<u> </u>	3-60			
		700-00		760.00	36.00	AREA 800.00	31.00	820.00	25.60	
	TABLE	NUMBER	= 3	. CTATI	A10/A		3-33			
637.90 330.00		700.00 876.00		760.00			31.00	820.00	25.00	
		NUMBER		STATIO	A10/A	AREA	5.00			
		700.69- 876.90			36.00	-800-00		-830-00-	-25-00	
	TABLE	HUNBER					7-43			
		705.00		760.00	0 AND 40-00		36-00	820.00	50.00	·
······································	·····									
						·				

Figure 9. Example of TAPE6 Output (continued)

					OFD	CFG	MA	PS		
		CV1	INPUT	HAP						<u></u>
					CFG	TABLE				
ABLECV	NUMBER			10.					7.	
	2.000			5.000	6.000		10.000	.903	-186	,
-886 -662	•935 •905	•977 •965	.986 -982	.988	.983	.970 .972	.958		•920 •932	
-822 -800	.867	•932 •922	•962 •952	•977 •970	.982	•978 •978	.970	•957		
ARANE TE	P NUMBE	CFG		MAP DER				- 01 D V	ALUE	
1		CIVER		ALF ANG					1.4500	
		 -								
		Part de la tradagnament								

Figure 9. Example of TAPE6 Output (continued)

					NEW	CFG	MA	P\$		
		CV1	INPUT	MAR					=101 <u>1111</u>	
						•				
					CFG	TABLE				
								: 7 .	•	
1.500				5.000				14-000	18.000	
.992	.992	.986	.976	. 766	-955	. 938	.924	.903	-886	
-932			•985				.957			
-861	904	.964	.981	.985	-981	.971	.963		.931	
-820 -797	.874 .864	.930 .919	.960 .949	.975 .967	•980 •976					
		CFG		MAP DER	IVATIVE	PARAME	TERS			
ARAMETE	E. NUMBEI			MAP DER	IVATIVE R DEFIN	PARAME LTION	TERS	NEW VAI	UE	
			5	ARANETE	A DEFIN	LTION	TERS			
ARAMETE			5	MAP DER	A DEFIN	LTION	TERS		.5000	
			5	ARANETE	A DEFIN	LTION	TERS			
ARAMETE 1			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
			5	ARANETE	A DEFIN	LTION	TERS			
1			5	ARANETE	A DEFIN	LTION	TERS			
1			5	ARANETE	A DEFIN	LTION	TERS			
1			5	ARANETE	A DEFIN	LTION	TERS			
1			5	ARANETE	A DEFIN	LTION	TERS			
1			5	ARANETE	A DEFIN	LTION	TERS			
1			5	ARANETE	A DEFIN	LTION	TERS			

Figure 9. Example of TAPE6 Output (concluded)

N>GET, DERB

N>GET .TAPES1=TEST:A .TAPES2=TEST2 .TAPES3=TEST3

N>BATCH C>DERB

DERIVATIVE PROCEDURE PROGRAM

ENTER CODE FOR MAPS TO BE CHANGED

- FOR INLET MAP CHANGES
- FOR NOZZLE/AFTROMY CHANGES
- FOR CY MAP CHANGES

1>1

ATS2 INLET MAP

ENTER CODE FOR OUTPUT DESIRED OF FOR TARES OUTPUT ONLY

- 1 FOR TAPES DUTPUT AND TAPET(NEW PIPSI) FILE

1>1

INLET TYPE - TWO DIMENSIONAL

MODE EXTERNAL COMPRESSION

D00046999		INLET MAP DEPIVATIVE PARAMETERS	
PHRHMETER	HUMBER	PAPAMETER DEFINITION	DLD VALUE
i		ACPECT PATIE	1 0000
2		SIDEPLATE CUTBACK (ACD ACPF)	0.000
3		FIRST PAMP ANGLE (DEG)	1.0000 .2000 7.3000
4		DESIGN MACH NUMBER	7.3000
5		COUL LIP BLUNTHESS	2.0000
Ř		TOUT THE BEST SOME SOME	.0200
<u>.</u>		THE OFF DOOP AFEA PATIO	.2000
		EXTERNAL COUL ANGLE (DEG)	.0200 .2000 17.5000
9 9			1.0000
10		EXIT FLAP ASPECT RATIO FOR BLEED EXIT FLAP AFEA RATIO FOR BLEED	2 0000
11		EXIT FLAP AFEA RATIO FOR BLEFT	1000
12		EXIT NUZZLE TYPE FOR BYPACS (CH=0,CND=1)	.4000
13		EXIT NOZZLE ANGLE FOR BYPASS(DEG)	1.0000
14		EXIT FLAP ASPECT RATIO FOR BYPASS	15.0000
15		ENTER COMPANY NAME AND	2.0000
16		COVILLER MEEN WHITH FOR EAGES	.2000
17		EXIT FLAR AREA RATIO FOR DYPASS SUBSANIC DIFFUSER AREA RATIO	:.5000
		ACMUNICATION OF TOTAL MAIL ANGLESSES	10.0000
18		SUBSONIC DIFFUSER LOSS COEFFICIENT	.: 900

Figure 10. Example of a Typical Terminal Session

INPUT NUMBER OF PARAMETERS TO BE CHANGED

1>4

INPUT THE PARAMETERS TO BE CHANGED FOLLOUED BY THE NEW VALUES IN PAIRS (PARAMETER NUMBER NEW VALUE)

1>1 .95 4 2.5 5	.03 18 .12	
PARAMETER HUMBE	R PARAHETER DEFINITION	NEW VALUE
1	ASPECT RATID	.9500
4	DESIGN MACH NUMBER	2.5000
5	COWL LIP BLUNTNESS	.0300
18	SUBSONIC DIFFUSER LDSS COEFFICIENT	.1200

ARE THE DERIVATIVE PARAMETERS COPRECT(0=YES | 1=NO)

1>0

DERIVATIVE PROCEDURE PROGRAM

ENTER CODE FOR MAPS TO DE CHANGED

- 1 FOR INLEY MAR CHANGES
- 2 FOR NOZZLEZAFTBODY CHANGES
- 3 FOR CY MAR CHANGES

1>2

CDER INPUT MAP

ENTER CODE FOR OUTPUT DESIRED

- O FOR TAPES DUTPUT DNLY
- 1 FOR TAPES DUTPUT AND TAPEL (NEW PIPSI) FILE

1>1

AFTERBODY TYPE =	CIMARISYMMETRIC DUAL NUZZLE	
	AFTERBODY MAP DEPIVATIVE PAPAMETERS	
PARAMETER NUMBER	PARAMETER DEFINITION	DUD VALUE
1	NOLZLE STATIC PRESSURE RATIO	1.0000
2	TAIL FIN CONFIGURATION	2.0000
3	TAIL FIN ANGLE(DEG)	0.0000
4	TAIL FIN FORE AND AFT LOCATION PATIO	,1736
5	BRSE AREA RATIO	0.0000

INPUT NUMBER OF PRPAMETERS TO BE CHANGED

1>1

Figure 10. Example of a Typical Terminal Session (continued)

INPUT THE PARAMETERS TO BE CHANGED FOLLOWED BY THE NEW VALUES IN PAIRS(PARAMETER NUMBER, NEW VALUE)

INS .:
PARAMETER NUMBER PARAMETER DEFINITION
5 BASE AREA RATIO

NEW VALUE

APE DERIVATIVE PARAMETERS CORRECT(0=YES 1=ND)

1>0

THE FOLLOWING ARE THE OLD TABLES(STATION(IN) VERSUS AREA(SOFT)) ACCOCIATED WITH A PARTICULAR ALGERA THE USER MAY CHANGE A TABLE VALUE FOR A PARTICULAR ALGERS PATIO

TABLE NUMBER = 1 A1 0/A9 = 2.18 STATION AND AREA 637.00 44.50 700.00 41.50 760.00 36.00 800.00 **31.00 820.00 25.00** 830.00 20.50 876.00 20.50 TRILE NUMBER = 2 A1 0/A9 ■ 2.50 STATION AND AREA 607.00 44.50 700.00 41.50 760.00 36.00 800.00 31.00 820.00 25.00 20.50 976.00 17.84 830.00 TABLE NUMBER = 3 A10/A2 = 3.33 STATION AND AREA 637.00 44.50 700.00 41.50 760.00 36.00 800.00 31.00 820.00 25.00 830.00 20.50 876.00 13.39 TABLE NUMBER = 4 A10/A9 * 5.00 STATION AND APEA 637.00 44.50 700.00 41.50 760.00 36.00 800.00 31.00 820.00 25.00 00.00 20.50 876.00 8.92 TABLE NUMBER = 5 A1 0√A9 = 7.43 STATION AND APER 637.00 44.50 700.00 41.50 760.00 36.00 800.00 31.00 820.00 25.00 830.00 20.50 876.00 6.00 DO YOU WISH TO CHANGE A TABLE (0=MO 1=YES) 1>0 DO YOU WISH TO CHANGE THE DEFAULT ASAB SCHEDULE(0=MD : 1=YES)

Figure 10. Example of a Typical Terminal Session (continued)

1>0

DERIVATIVE PROCEDURE PROGRAM

ENTER CODE FOR MAPS TO BE CHANGED FOR INLET MAR CHANGES FOR HOZZLE/AFTBODY CHANGES FOR CV MAP CHANGES 1>3 CVI INPUT MAP ENTER CODE FOR OUTPUT DESIRED O FOR TAPES DUTPUT DNLY 1 FOR TAPES DUTPUT AND TAPEL(NEW PIPSI) FILE 1>1 HOZZLE TYPE = ROUNI CONVERGENT-DIVERGENT HOZZLE CFG MAP DERIVATIVE PARAMETERS PARAMETER NUMBER PARAMETER DEFINITION DLD VALUE DIVERGENCE HALF ANGLE(DEG) 11.4500 INPUT NUMBER OF PARAMETERS TO BE CHANGED INPUT THE PARAMETERS TO BE CHANGED FOLLOWED BY THE NEW YALUE IN PAIRS(PARAMETER NUMBER/NEW YALUE) 1>: 12.5 PAPAMETER NUMBER PARAMETER DEFINITION NEW YALUE DIVERGENCE HALF ANGLE(DEG) 12.5000 APE THE DERIVATIVE PARAMETERS CORRECT(0=YES | 1=ND) 1>0 DERIVATIVE PROCEDURE PROGRAM ENTER CODE FOR MAPS TO DE CHANGED FOR INLET MAP CHANGES FOR NOZZLE-AFTRODY CHANGES

I>"END"

FOR CY MAP CHANGES

Figure 10. Example of a Typical Terminal Session (concluded)

If the user does not wish to continue, at this point a response of "END" will discontinue execution of the program.

When the option is selected, the name of the file which is the first card on the disk file is printed to inform the user of the type of file being used.

4.3.2 Output Code Type

The user at this time selects the type of output desired from the program. The options are:

- O TAPE 6 output only
- 1 TAPE 6 plus TAPE1 (a new PIPSI file)

Once the output code has been selected, the derivative parameters are listed at the terminal. Only the derivative parameters actually required for this input map file are listed and are modifiable.

4.3.3 Number of Parameters to be Changed

The user looks at the list of derivative parameters and decides how many are to be changed. That number is entered in response to the prompt.

4.3.4 Input of New Parameter Values

The user inputs the parameter number and parameter value in pairs for the parameters to be changed. The results are listed on the terminal for the user to review to see if they are correct.

4.3.5 Is Input Correct Code

If the above input has been correct, the user will enter a zero; if not the user will enter a one and the sequence of prompts and responses will be repeated. At this point, also, the user may enter "END" and the program will be terminated. After a zero has been entered for this prompt, the program executes and the next prompt will be the map type code prompt discussed in 4.3.1, at which time the user may execute another case or terminate execution.

4.4 Program Execution Sequence

In order to execute the Derivative Processor, the user must attach all disk files which are expected to be used to specific file names recognized by the program. These are:

TAPE 51 = Inlet file name.

TAPE 52 = Nozzle/afterbody drag file name.

TAPE 53 = Nozzle thrust coefficient file name.

A typical set of control cards is shown below:

ATTACH. TAPE 51 = ATS2DP2.

ATTACH, TAPE 52 = CD2R.

ATTACH, TAPE 53 - CV1.

where ATS2DP2, CD2R and CV1 are previously constructed files existing on the user permanent files.

The user then attaches the Derivative Processor program,

ATTACH, DERIVP = existing permanent file name of an absolute binary

file of the program.

It should be noted here that a pre-existing absolute file must have been generated and saved from a compilation and load of the program. This is necessary in order that the program be able to run in less than 60K octal words in an interactive environment.

DERIVE

This executes the program and is the absolute overlay file name and <u>must</u> be used when executing the absolute file. The user then responds to prompts once the program is executing. After an "END" is entered, the program terminates execution. At this time the user may elect to perform different types of outfile manipulations, such as saving, listing, disposing, or merging.

SECTION V SAMPLE CASES

The purpose of the sample cases for the derivative procedure is to demonstrate the major flow paths in the program used to produce new inlet and nozzle/aftbody maps. Three sample sets are provided for the derivative procedure program. One set will be used to demonstrate the major flow paths used to produce a new inlet map, the second sample set will be used to demonstrate the flow paths used to produce a new nozzle/aftbody drag map, and the third set will be used to demonstrate the flow paths used to produce a new nozzle internal performance ($C_{\text{F}_{\text{C}}}$) map.

Each of the sample cases is described separately in the sections which follow. For each of the sample cases, the following information is provided:

- (1) Old (baseline) input data tables and baseline derivative parameters for which the data tables correspond.
- (2) A list of new derivative parameters for which a new (perturbed) map is to be produced.
- (3) a set of terminal input commands used to interactively generate the new set of input data tables.
- (4) A new set of input tables produced by the derivative procedure program.

5.1 INLET DERIVATIVE PROCEDURE SAMPLE CASE

The baseline inlet used to demonstrate the inlet derivative procedure is Configuration #8, File Name ATS2. The inlet is an external compression, four-shock inlet designed for a free-stream Mach number of 2.0. The inlet has two movable external ramps, a 7.3° initial ramp angle, a

boundary layer control bleed system consisting of porous bleed on the second and third ramp surfaces and sideplates; and a throat bleed slot located aft of the normal shock. The throat slot also acts as a bypass to remove excess inlet airflow for matching engine airflow demand with inlet supply. The inlet characteristics were built up from engineering analyses and available data from similar configurations and components. A sketch of the configuration is shown in Figure 11.

The predicted inlet performance characteristics for the ATS2 inlet are shown plotted in figures 12 through 21. These performance characteristics are entered as old (baseline) data tables (Figure 22).

Each set of inlet input tables in the library is accompanied by a set of derivative parameters that describe the configuration in terms of its important variables. An example showing the derivative parameters for the ATS2 inlet is presented in Figure 23. In addition to the complete set of derivative parameters for the library inlet configuration, a new set of inlet derivative parameters must be input by the user to specify the new values of the parameters that are to be used in the new configuration calculations. The new derivative parameters for the ATS2 inlet test case are shown in Figure 24.

The set of interactive terminal commands input by the user to run the inlet derivative procedure program is presented in Figure 25.

The output file obtained as a result of the ATS2 inlet sample case run is presented in Figure 26. The old (original library configuration) inlet maps are printed out first together with the original derivative parameters. Next, the new set of inlet maps is printed out, with the new set of derivative parameters shown for reference.

5.2 NOZZLE/AFTBODY DRAG DERIVATIVE PROGRAM SAMPLE CASE

The baseline nozzle/aftbody configuration used to demonstrate the operation of the nozzle/aftbody drag map derivative procedure is the twin.

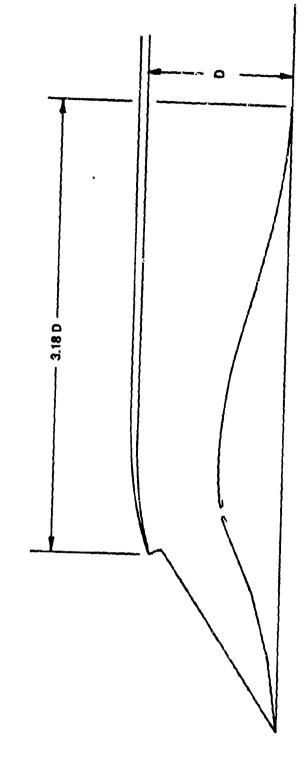


Figure 11. ATS2 Inlet

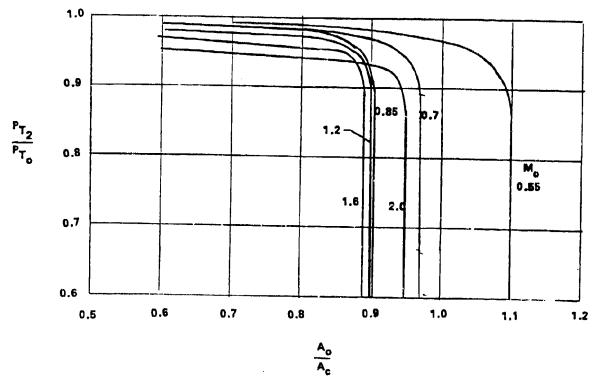


Figure 12. Total Pressure Recovery vs. Mass Flow Ratio

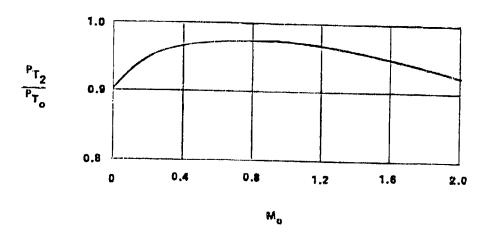


Figure 13. Matched Total Pressure Recovery

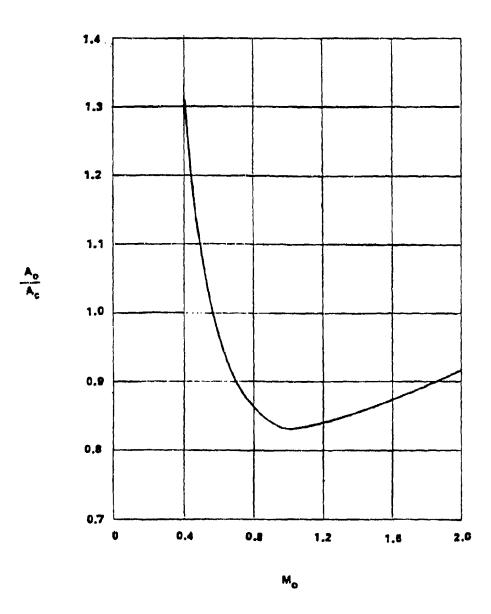


Figure 14. Matched Inlet Mass Flow Ratio

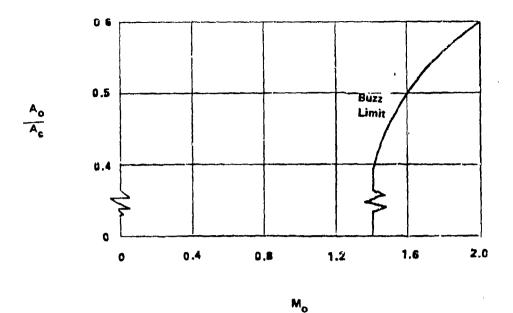


Figure 15. Buzz Limit Mass Flow Ratio

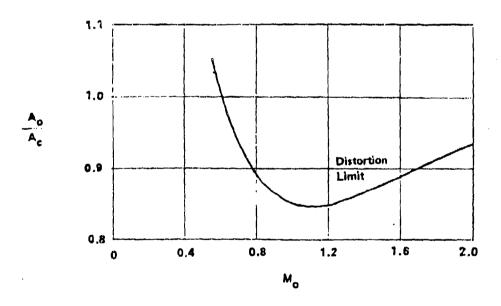


Figure 16. Distortion Limit Mass Flow Ratio

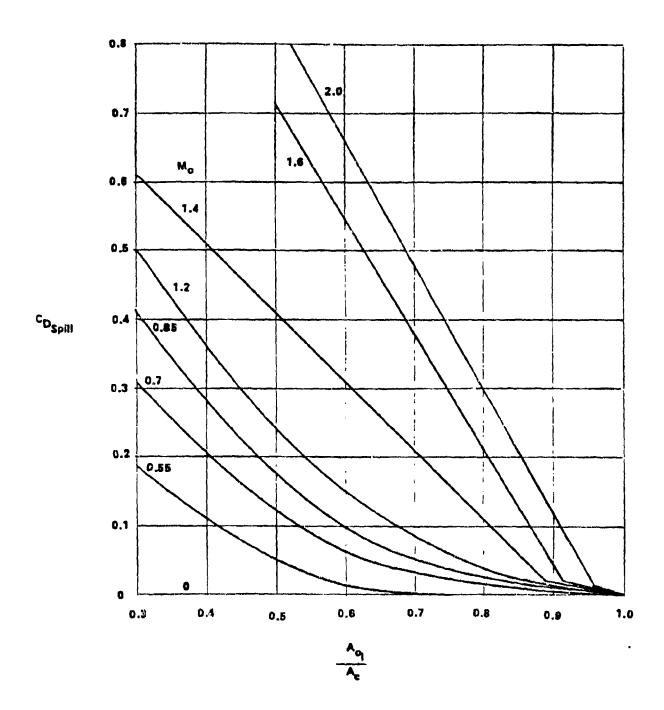
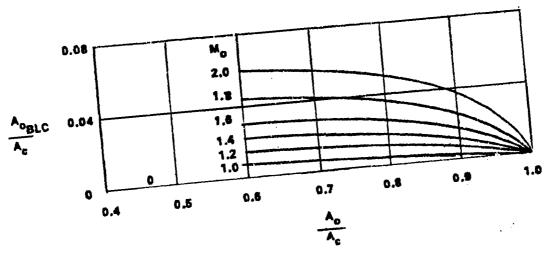
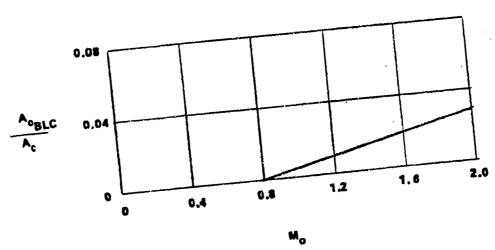


Figure 17. Spillage Drag vs. Inlet Mass Flow Ratio



(a) AoBLC Ac VS. Ao Ac



(b) Matched Apple / Ac vs. Mo

Figure 18. Reference Spillage Drag and Mass Flow Ratio

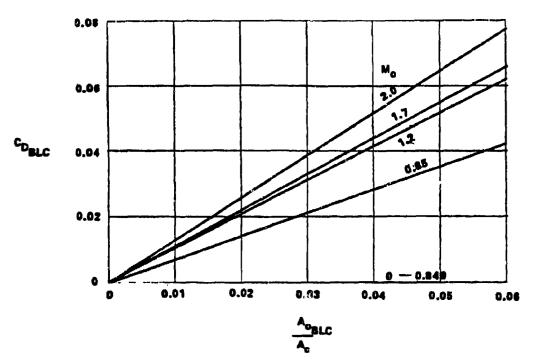


Figure 19. Boundary Layer Bleed Drag vs. Bleed Mass Flow Ratio

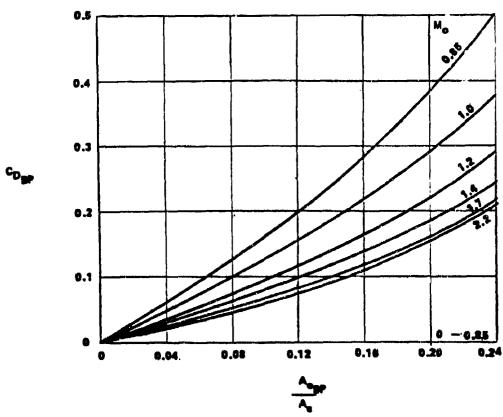


Figure 20. Bypass Drag vs. Bypass Mass Flow Ratio

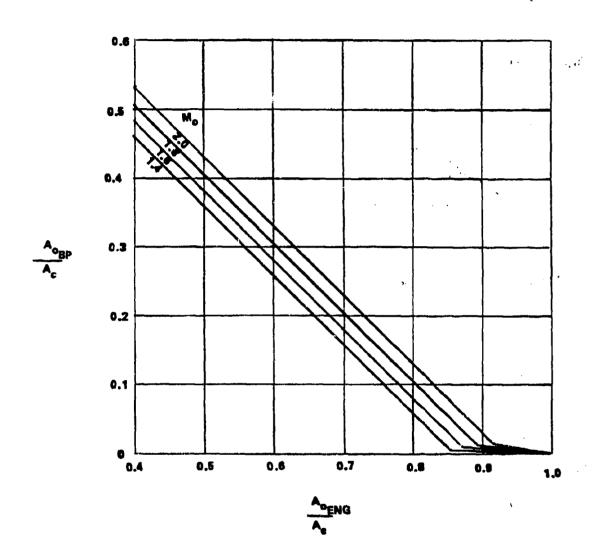


Figure 21. Bypass Mass Flow Ratio vs. Engine Demand Mass Flow Ratio

```
" ATSZ INLET PAP
                                                    1.00 25.00
                                       .20 17.50
                                 .03
                         2.50
           . 20
                  7.30
    .95
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                                                   . 12
                                 .20 0.00 0.00
                15.00 2.00
3.00 .75
           1.00
     .10
- ... 1.00
                                1.00
           1.25
            3.
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                 2.500
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6.000
           .200
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          6.000
                              1.900 2.500
          .700
    .550
                        1.300
                  .850
                                       . 859
                                              . 879
                         .740
                                .443
                  .719
    .559
           .639
                                       .775
         .990
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                                .949
                  .994
                         .968
                                .759
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           .988
                         . 471
                                .973
                  .987
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                 .584
                         .568
                                       .732
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           .500
    .416
    .453
                                . 047
                                               . 680
                                       . 935
                  .957
                         .953
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                                               . 809
                 .637
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                                . 776
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                 . 927
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                                       .902
           .937
    .938
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         .594
                         .704
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                                . 896
                 .694
                                        . 926
                                               . 932
    .493
                                 . 975
                                                             .790
                                        .865
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                 . 980
                         .884
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            .774
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                                 .450 1.300 1.600 1.700 7.500
                          .700
                  .550
           .549
    0.000
           .798
                  1.000
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           0.000
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           .798
                 1.000
                 0.000
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    0.000
                 . 399
                         .479
                                . 559
                                      .572. 1.000
            .320
     .240
                                .002 0.000 0.000
                 .048
                         .011
     .157
            .096
                                              .719
                                .560
                                       .639
                                                      .759
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                   .400
     .240
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                                .029
            .171
                   .103
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                          .490
                                .560
                                      .640
                   .430
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                   .215
     .442
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                                              1.000
                                 .779
                                        .798
                   .615
                          .703
     .264
            .439
                                              0.000
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                   .725
                           .170
                                 .025
            .456
     .764
                                        . *52
                                              1.000
            .551
                   .643
                           .734
                                 . 943
     .459
                                  .023
                                       0.000
                                              0.000
                   .402
                           .230
            .593
     .766
                   .797
                                        .961
                                              1.000
            .609
                           . 899
                                  . 956
     .500
                                       0.000
                                              0.000
                           .137
                                  .010
                   . 333
     .925
            .535
```

Figure 22. ATS2 Inlet Input Data Tables

```
TABLEBA
   0.000
           1.000
                   2.530
   9.000
           0.000
                   0.000
 TARLESS
           1.COO
   6.000
                   2.500
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                    . 999
 YABLE4
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                    . 850
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                                  2,050 2.500
   0.000
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                            .044
                                    . 046
   0.000
            .011
   0.000
           0.000
                   0.030
                           0.000
                                   0.000
   0.000
           0.000
                   0.000
                           0.000
                                   0.000
                            .075
   0.000
            .007
                    .014
                                    .047
   8.000
            .010
                    .021
                            .04?
                                    .052
   0.000
            .011
                    .07?
                            .044
                                    . 066
   0.000
            .011
                    .023
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                                    .061
 TABLES
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                           1.000
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   6.000
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                                   1.300
                                           1.600
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   ....
            .042
                    .043
                            -125
                                            .208
                                                   .249
           0.000
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            .062
                            .198
                                    . 280
                                            .360
   0.000
                    .125
                                                    .500
                                                    .375
   0.000
            .050
                    .100
                            .156
                                    . 717
                                            .290
            .036
                                                    .245
                    .075
   0.000
                            .117
                                    .161
                                            .217
   0.000
            .030
                    .057
                            .796
                                            .161
                                                    .234
                                    .133
   D.COO
            .026
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                            .084
                                            -144
                                                    .220
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                                    .121
   0.000
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            .023
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 TABLE6A
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                           5.000
                                   9.000
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                                                  2.200 2.500
            .900
   0.000
                   1.000
                           1.300
                                   1.600
                                           1.900
            .797
   -.000
  0.000
           0.000
   -.001
            . 800
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           0.000
                                    . 412
            .567
                    .674
    .486
                            .731
    .009
            . 609
                    .005
                            .903
                                   0.000
                            .753
    .500
            .544
                    .707
                                    . 838
                            .004
    .015
            .014
                    .011
                                   0.000
    .57?
            -611
                    .751
                            .784
                                    . 877
                            .013
                                   0.000
    .024
            .022
                    .015
    .545
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    .033
            .037
                    .024
                            .922
                                    .015
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    .570
                    .742
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                                    .023
                    .041
                            .977
                                           6.000
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                    .794
                                            , 444
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             .404
                                    . 426
     .066
             .061
                    .055
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 TABLEKA
              5.
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             . 200
                   1.300
                           1.400
                                   2.500
           0.000
   0.000
                    .011
                            .07?
                                    .033
"TABLET
              6.
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   2.000
                   4.000
                           4.000
                                   4.000
                                           4.000
           1.599
   0.000
                   1.600
                           1.900
                                   7.700
                                           2.500
           1.000
   0.000
   0.000
           0.000
           1.000
   0.000
           0.000
   0.000
            .748
     .350
                    .752
                           1.000
     .404
             .004
                   0.000
                           0.000
             .798
                    . 907
     .366
                           1.000
     .442
             .004
                   0.000
                           0.000
     .373
                    . 664
                           1.000
             .855
     .485
             .013
                   0.000
                           0.000
     .400
             . *15
                    . 430
                           1.000
             .015
                   0.000
                           0.000
     .532
```

Figure 22. ATS2 Inlet Input Data Tables (concluded)

INLET TYPE = TWO DIMENSIONAL

MODE= EXTERNAL COMPRESSION

LINDE- EVICKUME	COLIFF: EGG VEIT	
	INLET MAP DERIVATIVE PARAMETERS	
PARAMETER NUMBE	R PARAMETER DEFINITION	DLD VALUE
1	ASPECT RATIO	1.0000
ខ	SIDEPLATE CUTBACK	.2000
3	FIRST RAMP ANGLE(DEG)	7.3000
4	DESIGN MACH NUMBER	2.0000
5	COUL LIP BLUNTHESS	.0200
6 7	TAKE OFF DOOR AREA	.2000
7	EXTERNAL COWL ANGLE(DEG)	17.5000
8	EXIT NOZZLE TYPE FOR BLEED	1.0000
9	EXIT NOZZLE ANGLE FOR BLEED(DEG)	15.0000
10	EXIT FLAP ASPECT RATIO FOR BLEED	2.0000
11	EXIT FLAP AREA FOR BLEED	.1000
12	EXIT NOZZLE TYPE FOR BYPASS	1.0000
13	EXIT NUZZLE ANGLE FOR BYPASS(DEG)	15.0000
14	EXIT FLAP ASPECT RATIO FOR BYPASS	2.0000
15	EXIT FLAP AREA FOR BYPASS	.2000
16	SUBSONIC DIFFUSER AREA RATIO	1.5000
17	SUBSONIC DIFFUSER TOTAL WALL ANGLE(DEG)	
18	SUBSONIC DIFFUSER LOSS COEFFICIENT	.1000

Figure 23. Old Inlet Derivative Parameters

PARAMETER NUMBER	PARAMETER DEFINITION	NEW YALUE
1	ASPECT RATIO	. 9500
4	DESIGN MACH NUMBER	2.5000
5	COWL LIP BLUNTNESS	.0300
18	SUBSONIC DIFFUSER LOSS COEFFICIENT	.1200

Figure 24. New Inlet Derivative Parameters

N>GET . DERB

N)GET, TAPESI = TESTIA, TAPES2 = TEST2, TAPES3 = TEST3

H>BFITCH C>DERB

DERIVATIVE PROCEDURE PROGRAM

ENTER CODE FOR HAPS TO BE CHANGED

- 1 FOR INLET MAP CHANGES
- 2 FOR NOZZLE/AFTBUDY CHANGES
- FOR CY MAP CHANGES

I>1

ATS2 INLET MAP

ENTER CODE FOR OUTPUT DESIRED

- 0 FOR TAPES BUTPUT DNLY
- 1 FOR TAPES DUTPUT AND TAPEI (NEU PIPSI) FILE

1>1

INLET TYPE - TUD DIMENSIONAL

MODE- EXTERNAL COMPRESSION

	INLET MAP DERIVATIVE PARAMETERS	
PARAMETER NUMB	ER PARAMETER DEFINITION	DLD VALUE
1	ASPECT RATIO	1.0000
2	SIDEPLATE CUTBACK(ACB/ASPF)	.2600
3	SIDEPLATE CUTBACK(ACB/ASPF) FIRST RAMP ANGLE(DEG)	7.3000
4	DESIGN MACH NUMBER	2.0000
5	COUL LIP BLUNTNESS	.0200
6	TAKE OFF DOOR AREA RATIO	.2000
7	TAKE OFF DOOR AREA RATIO EXTERNAL COUL ANGLE(DEG) EXIT NOZZLE TYPE FOR BLEED(CN=0;CND=1) EXIT NOZZLE ANGLE FOR BLEED(DEG)	17.5000
0 9	EXIT NOZZLE TYPE FOR BLEED(CH=0,CND=1)	1.0000
9	EXIT NOZZLE ANGLE FOR BLEED(DEG)	15.0000
10	EXIT PLFF MSPECT RMTID FOR BLEED	2.0000
11	EXIT FLAP AREA RATIO FOR BLEED	.1000
12	EXIT FLAP AREA RATIO FOR BLEED EXIT HOZZLE TYPE FOR BYPASS(CN=0,CND=1)	1.0000
13	EXIT NOZZLE ANGLE FOR BYPASS(DEG)	15.0000
14	EXIT FLAP ASPECT RATIO FOR BYPASS	2.0000
15	EXIT FLOR OREO ROTIO FOR BYPACS	.2000
16	EXIT FLAP AREA RATIO FOR BYPASS SUBSONIC DIFFUSER AREA RATIO	1.5000
17	SUBSONIC DIFFUSER TOTAL WALL ANGLE(DEG)	10.0000
10	SUBSONIC DIFFUSER LOSS COEFFICIENT	.:000

Figure 25. Terminal Input Commands for Inlet Derivative Program

INPUT NUMBER OF PARAMETERS TO BE CHANGED

134

INPUT THE PARAMETERS TO BE CHANGED FOLLOWED BY THE NEW VALUES IN PAIRS(PARAMETER NUMBER, NEW VALUE)

1>1 .95 4 2.5 5	.03 18 .12	
PARAHETER NUMBER	R PARAMETER DEFINITION	HEL VALUE
1	ASPECT RATID	.9500
4	DESIGN MACH NUMBER	2.5000
5	COUL LIP BLUNTHESS	.0300
18	SUBSONIC DIFFUSER LOSS COEFFICIENT	.1200

ARE THE DERIVATIVE PARAMETERS CORRECT(9-YES 1-MO)

1>0

DERIVATIVE PROCEDURE PROGRAM

ENTER CODE FOR MAPS TO BE CHANGED

1 FOR INLET MAP CHANGES

2 FOR NOZZLE-AFTRODY CHANGES

3 FOR CY MAR CHANGES

1>2

CD2R INPUT MAP

ENTER CODE FOR DUTPUT DESIRED

O FOR TAPES DUTPUT DNLY

1 FOR TAPES DUTPUT AND TAPEI (NEW PIPSI) FILE

1>1

IN ICKDUDI IIIG -	CA-TAILGITING IRAC BURK TOLICALLE	
	AFTERBODY MAP DERIVATIVE PARAMETERS	
PARAMETER NUMBER	PARAMETER DEFINITION	DLD VALUE
1	NUZZLE STATIC PRESSURE RATIO	1.0000
2	TAIL FIN CONFIGURATION	2.0000
3	TAIL FIN ANGLE(DEG)	0.0000
ă.	TAIL FIN FORE AND AFT LOCATION RATIO	.1736
5	BASE AREA RATIO	0.0000

INPUT NUMBER OF PARAMETERS TO BE CHANGED

RETERRIBY TYPE - CT.OVICAMMETRYS NAME

I>"END"

Figure 25. Terminal Input Commands for Inlet Derivative Program (concluded)

·-·-·					ara	INCEY	W.	75
<u> </u>		ATS	2 INLET	MAP	···			
<u> </u>		,			LOCA	L MACH	number	
TABLE 1	WH3 FR	OF PD1	• 278	J.				
0.000	. 200	2.000						
			· · · · · · · · · · · · · · · · · · ·		MECH	VERT VS	WK22 V	COA
TABLEZA MUMBER D			UIWIS =		7.	7.		9.
.550	.700	.630	1.200	1.600	2.000	10		₹•
- 2700		.400	1.000	1.035	1.073	1.100		
.992	.991	. 945	.769	. 150	.933	.075		
.600	.700	. 400	.900	. 950	.978	••••		
. 440	. 440		- 1979	. 743	700			
.500	.600	.700	. 8 00	. 4 50	. 875	.905		
.990	. 990	. 747	.943	. 975	.962	. 900		
.500	. 600	.700		. 830	.077	.40%		
.900	.979	.977	.973	. 447	.755	. 160		
.500	.600	.700	. # 00	. 8 50	.875			
.476	. 470	.463	. 770	*444	.440	.459	.400	
.500	-600	.700	.000	. 900	. 430	. 735	-943	. 450
.958	. 453	,949	.744	. + 15	.925	.420	.900	. # 50
					MATC	HED INL	EY RECO	VERY
TABLEZB	MUTAER	of Par	MTS -	٩.				
0:000	*500	.400	.000	-110	1.000	1:500	1.000	2.000
. 400	. 9 50	.965	.972	. 975	.975	.967	.448	. 925
					MATC	HED RA'S	S FLDW	
TABLESC	MUTGER	OF PO1	MTS -	7.			ه دخمیستانانی جا	
.400	.600	.800	1.000	1.200	1.608	2.000		
1.310	,418	.067	.000	.040	-872	*414	· , - · · · · · · · · · · · · · · · ·	
					802.	CEMIT		
TABLEZO	- NOTER		MIS A					
*#\$(EZU 0.000 0.000	70788X 1.399 9.000	UF FUI 1.400	1.600	1.000	Z.000		-	

Figure 26. Derivative Procedure Output File

						COLLIGN	LINIT		~		
ABLEZE	NUM BER	DF POI	NTS -	٠.							
.550	.700	.000	1.200	1.400	2.000						
1.077	.435	. 3 40	.546	.170	.435		^	····		·	
					3P 3L	TABE DE	76	······································			
TABLES	AUYSEK	UF Y P	UINTS 0		•			-			
MUMBER D	F X POY	472 -	Z.	Z.	7.	4.	٠.	۹.	7.	7.	T.
0.000	.549	.530	.703	. 1 50	1.200	1.400	1.600	2.000			
8.000	1.000		····	· · · · · · · · · · · · · · · · · · ·							
0.000	0.900										
0.000	1.000										
0.000	0.000										
.305	.400	.500	.600	.700	.725	1.000					
.105	.110	.052	.019	002	3.000	0.000					
-303	.400	-200	. 500	.785	.800	. 455	. 430	1.000			
.310	.207	*753	500,	.032	:013	.005	0.000	9.000			
.300	.400	.500	.400	.700	. 800	. 900	. 463	1.000			
.410	.280	4177	-044	*030	.026	-010	A. 600	0.000	,		
.308	.400	.700	.600	.700	. 800	.700	. 458	1.000			
.500	. 340	-240	. 1 90	-084	.030	.014	0.000	9.000			
-300	.700	.700	.800		.404	1.000					
.750	.437	.210	.110	.022	9.000	0.500					
.500	.600	.700	. 8 00	. 415	. 928	1.000					
.713	.770	.370	.210	.021	0.000	0.000	*********		····	·····	
. 300	.700	.800	.900	. 757	. 962	1.000					
-840	-486	.290	.116	.010	0.000	0.000					
TABLESA 0.000	1.000		MTS =	. 3.		RENCE S					
0.000	0.000	0.000									
					MEFE	RENCE F	ASS PLO	<u></u>			
		or equ	MTS -	3.	NEFE	RENCE P	ASS PLO)¥			
7ABLE38 0.000 1.000	1.000	OF POI 2.000	MTS -	3.	NEFE	RENCE F	ASS PLO)¥			
	1.000	2.000	MTS -	3.				ED DKVE	antiques and an analysis of the same of th		
1.000	1.000	2.000			500	IBANY I	YEN SCE	ED DEAG			
0.000 1.000	MONREX 1.000	2.000 1.000	WINTS	· · · · · · · · · · · · · · · · · · ·	ECJUR ROMES		YEN SCE	ED DEAG			
0.000 1.000 YABLE4 0.000	1.000 1.000 NUMBER .849	2.000 1.000	1.200	1.700	#500# #50#88 2.000	IBANY I	YEN SCE	ED DEAG			
0.000 1.000 1.000 0.000 0.000	1.000 1.000 HUMBER .849 .010	2.000 1.000 UP X-1.000	1.200 .040	1.700	ECJUR ROMES	IBANY I	YEN SCE	ED DEAG			
0.000 1.000 0.000 0.000	1.000 1.000 HUMBER .849 .010	2.000 1.000 UP 147 .850 .020	01#13# 1.200 .040	1-740 .940	#500# #50#88 2.000	IBANY I	YEN SCE	ED DEAG			
0.000 1.000 0.000 0.000 0.000	1.000 1.000 1.000 800 800 0.000 0.000	2.000 1.000 0.000 0.000	1.200 .040 0.000	1.700 .040 0.000	#500# #50#88 2.000	IBANY I	YEN SCE	ED DEAG			
0.000 1.000 0.000 0.000 0.000 0.000	HUMBER .849 .010 0.000 0.000	2.000 1.000 1.000 .850 .020 0.000 .014	1.200 0.000 0.000 0.000	1.700 .940 0.000 0.000 0.000	#500# #50#88 2.000	IBANY I	YEN SCE	ED DEAG			
0.000 1.000 0.000 0.000 0.000 0.000	HUMBER .849 .010 0.000 0.000	2.000 1.000 1.000 .850 .020 0.000 .014	1.200 .040 0.000 0.000 0.000	1.700 .040 0.000 0.009 .042	#500# #50#88 2.000	IBANY I	YEN SCE	ED DEAG			
0.000 1.000 0.000 0.000 0.000 0.000	HUMBER .849 .010 0.000 0.000	2.000 1.000 1.000 .850 .020 0.000 .014	1.200 0.000 0.000 0.000	1.700 .940 0.000 0.000 0.000	#500# #50#88 2.000	IBANY I	YEN SCE	ED DEAG			

Figure 26. Derivative Procedure Output File (continued)

					8474	SS DRAG	;			
rables	4UH BER	DF X-F	QINTS-	7.	MUNBE	R OF Y-	-PEINTS -			
0.202	. 849	.850	1.000	1.200	1.400	1.700	2.200			
0.000	.340	-080	-150	.190	- 500	-240				
0.000	0.000	9.000	0.000	0.000	0.000	0.000				
0.500	0.000	0.000	0.000	0.000	0.000	0.000				
0.003	-062	1152	-1148	.280	. 380	. 500				
0.000	.050	.100	.154	.217	290	.375				
9.000	.036	.075	.117	. 1 62	- 220	.290				
0.000	.030	200.	-047	-133		-241				
0.000	.025	.052	.081	. 116	.160	.216				
0.000	.020	.045	.874	.110	-153	.210				
············			···		BOUN	DARY LA	YER BLEE	D DRAG		
TABLESA	NUMBER	OF Y P	CENTS .		١.					
WHIER 3	F K POT		Ž.		7.	7.	7.			
0.000	.900	1.000	1.200	1.400	1.600	1.800	2.000	***		
0.000	1.000			•••	••••					
0.000	0.000									
0.000	1.000									
0.300	0.300									
.600	.700	-1131	. 900	1.000						
.008	.007	.005	.003	0.000						
.600	.700	.440	.900	1.000						
-014	.013	.010	.006	0.000						
.600	.700	.857	.900	1.000						
.022	.020	.015	.012	6.000						
	700		.101	- 430-	1.000					
.030	.029	.026	.0Z0	.014	0.000					
.600	.700	.400	.706	. 930	1.000					
.00%	-042	037	.025	.021	U. 000					
.600	.700	.000	.900	. 730	1.000					
.040	.056	.090	.017	.030	0.000					
					MATC	HED BOW	HIDARY LA	YER BLEE	b	
TABLE 68	NU4 BER	OF POS		5.						
0.000		1.200	1.600	2.000			······································			
	0.000	.010	.020	.038						

Figure 26. Derivative Procedure Output File (continued)

					SYPAS	S MASS FL	.DW	
TABLET NUMBER D		OF Y P	OINTS -	2.4.	••	4.	v 4.	
0.000	1.344	1.400	1.800	1.100	2.000			
0.000	1.000							
0.000	6,000							
0.000	1:300							
0.000	0.000							
.400		.859	1.000					
.481	.008	0.000	0.000					
.400	. 172	.882	1.000					•
.483	.010	0.000	0.000					
.400	.192	.906	1.000					
.506	-,014	0.000	0.000					
.400 .532	.915	. \$30	1.000					
							_	
vve & v u		INL				PARAMETER		
TARAMETE	R TURBE			MAP DER			OLO AVE	VE
TARRHETE	म ्पणमङ्	K		AKAPETE			OLO AVE	UE OOO
	য ্বচন্ত্ৰ	R ASPEC		AKAPETE			OLO VAL	0000
1		ASPEC SIDEP	T RATIO	AKAPETE	DEFIN		OLO VAL	2000
1		ASPEC SIDEP FIRST	T RATIO	AKAMETE	DEFIN		1.	0000 2000 3000
1 2 3		ASPEC SIDEP FIRST DESIG	T RATIO	TRACK NGLE (DE NUMBER	DEFIN		- GLG VAL 1. 7. 2-	0000 2000 3000
1 2 3 4		ASPEC SIDEP FIRST DESIG CUWL TAKE	T RATIO LATE CO RAMP A R MACH LIP BLU OFF BDO	TRACK MGLE (DE) MUMBER MTMESS IR AREA	DEFIN:		GLG VAL 1. 7. 2.	0000 2000 3000 0000
1 2 3 4		ASPEC SIDEP FIRST DESIG CUWL TAKE	T RATIO LATE CO RAMP A R MACH LIP BLU OFF BDO	TRACK TRACK NGLE (DE) NUMBER NTNESS	DEFIN:		1. 7. 2.	0000 2000 3000 0000 0200
1 2 3 4		ASPEC SIDEP FIRST DESIG CUML TAKE EXTER	T RATIO LATE CO RAMP A M MACH LIP BLO OFF DOO MAL COM MUZZLE	TRACK TRACK NGLE (DE) NUMBER NTMESS IR AREA L ANGLE TYPE FU	DEFINI ()	TION	010 VAL 1. 7. 2.	0000 2000 3000 0000 0200 2000
1 2 3 4 5 6 7		ASPEC SIDEM FIRST DESIG CUML TAKE EXTER EXTER	T RATIO LATE CO RAMP A M MACH LIP BLO OFF DOO MAL COM MOZZLE MOZZLE	TRACE TRACE TRACE THE STATE TRACE THE TRACE TH	DEFINITION OF THE PROPERTY OF	D(DES)	1. 7. 2.	0000 2000 3000 0000 0200 2000 5000
1 2 3 4 3 6 7 7		ASPEC SIDEM FIRST DESIG CUWL TAKE EXTER EXIT EXIT EXIT	T RATIO LATE CO RAMP A N MACH LIP BLO OFF DDO MAL COM MOZZLE NOZZLE FLAP AS	TRACK NGLE (DE) NUMBER MINESS R AREA L ANGLE FI ANGLE FI PECT RA	DEFINATION OF THE PORT OF THE	D(DES)	1. 7. 2. 17.	0000 2000 3000 0000 0200 2000 5000
1 2 3 4 5 6 7		ASPEC SIDEP FIRST DESIG COWL TAKE EXTER EXIT EXIT EXIT	T RATIO TATE CO RAMP A M MACH LIP BLO OFF DOO MAL COW MUZZLE FLAP AS FLAP AK	TRACK NGLE (DE) NUMBER MTMESS R AREA L ANGLE TAMGLE TAMGLE PECT RAI EA FUR	DEFINITION OF THE PORT OF THE	DI DES)	100 VAL 7- 2- 17. 15.	0000 2000 3000 0000 0200 5000 0000
1 2 3 4 5 6 7 10		ASPEC SIDEP FIRST DESIG CUML TAKE EXTER EXIT EXIT EXIT EXIT	T RATIO TAMP A N MACH LIP BLO OFF DOO NAL COM NOZZLE FLAP AS FLAP AK HOZZLE	TRACK NGLE (DE) NUMBER NTMESS IR AREA L ANGLE TYPE FUR PECT RA' EA FUR TYPE FOR	DEFINITION OF THE PORT OF THE	D(DES) BLEED	1. 7. 2. 17. 15.	2000 3000 3000 0000 0200 2000 2000 0000 0000
1 2 3 4 7 6 7 10		ASPEC SIDEM FIRST DESIG CUML TAKE EXTER EXIT EXIT EXIT EXIT EXIT EXIT	T RAYIO CATE CO RAMP A M MACH LIP BLU OFF DDO MOZZLE MOZZLE FLAP AS HOZZLE MOZZLE MOZZLE HOZZLE MOZZLE MOZZLE MOZZLE MOZZLE	TRACK NGLE (DEC NUMBER NTMESS IR AREA L ANGLE TYPE FUI ANGLE FI PECT RA EX PUR TYPE FUI ANGLE FI	(DEG) (BLEED OR BLEED (TO FOR FLEED R BYPAS	D(DES) SS(DES)	1. 7. 2. 17. 15.	2000 2000 2000 2000 2000 2000 2000 200
1 2 3 4 5 6 7 10 11 12 13		ASPEC SIDEP FIRST DESIG CUME TAKE EXITER EXIT EXIT EXIT EXIT EXIT EXIT	T RATIO LATE COU RAMP A M MACH LIP BLU OFF ODO MAL COW MUZZLE FLAP AS FLAP AM MUZZLE MUZZLE FLAP AS FLAP AS FLAP AS FLAP AS	TRACK NGLE (DE) NUMBER NTMESS IR AREA LYPE FUL ANGLE FI PECT RAT EA FUR TYPE FUL ANGLE FI PECT RAT	OEGI (BLEED OR BLEED (IO POR SLEED REPPAS OR BYPAS	D(DES) SS(DES)	100 VAL	0000 2000 2000 0000 2000 2000 0000 000
1 2 3 4 7 6 7 10		ASPEC SIDEP FIRST DESIG CUME TAKE EXTER EXIT EXIT EXIT EXIT EXIT EXIT EXIT EXIT	T RATIO TATE CO RAMP A M MACH LIP BLO OFF DOO MAL COW MOZZLE FLAP AS FLAP AS HOZZLE FLAP AS FLAP AS FLAP AS FLAP AS FLAP AS	TRACK MGLE ODE MUMBER MIMESS R AREA L ANGLE TYPE FUI ANGLE FI PECT RA' TYPE FUI ANGLE FI PECT RA' LEA FUR LEA	OEGI BLEED OR BLEED FIO FOR SLEED FIO FOR SLEED FIO FOR SLEED FIO FOR SLEED	84.57.2. 22. (DEE) 9FEED 0(DEE)	100 VAL	-
1 2 3 4 5 6 7 10 11 12 13		ASPEC SIDEP FIRST DESIG CUWL TAKE EXTER EXIT EXIT EXIT EXIT EXIT EXIT EXIT EXIT	T RATIO TATE CO RAMP A M MACH LIP BLU OFF DOO MAL COW MUZZLE FLAP AS FLAP AK HOZZLE FLAP AK FLAP AK HOZZLE FLAP AK HOZZLE FLAP AK HOZZLE FLAP AK HOZZLE FLAP AK	TRACK NGLE (DE) NUMBER MINESS R AREA IL ANGLE ANGLE F PECT RA EA FUR TYPE FOI ANGLE F FECT RA EA FUR FUSER AI	OEGI R BLEED DR BLEED FID FOR SLEED R BYPAS DR BYPAS TO FOR BYPAS REA RAT	SS (DES) OLDES	100 VAL	0000 2000 3000 0000 0000 0000 0000 0000
1 2 3 4 4 5 6 7 7 10 11 12 12 13 14 15 15		ASPEC SIDEP FIRST DESIG CUME TAKE EXIT EXIT EXIT EXIT EXIT EXIT EXIT EXI	T RATIO TATE CO RAMP A M MACH LIP BLO MAL COM MUZZLE FLAP AS FLAP AS FLAP AS FLAP AS MIC DIF	TRACK MGLE (DEC MUMBER MTHESS IL ANGLE TYPE FUI ANGLE FI PECT RA TYPE FOI ANGLE FI PECT RA TYPE FI PECT RA T	(DEG)	84.57.2. 22. (DEE) 9FEED 0(DEE)	100 VAL	0000 2000 3000 0000 0000 0000 0000 0000

Figure 26. Derivative Procedure Output File (continued)

					~~ ~	INCEY	***	PS
		ATS	2 INLET	MAP				
					LOGA	L HACH	NUMBER	
TABLET	NUMBER	OF PO1	HTS -	3.		,		
0.000	.200	2.100			······································			
					WECT	VERT VS	- 8235 F	CDE
TABLEZA		_(IIEA3	ชาการ	·····				
NUMBER O			7.		7.	7.		•
.550	.700	.850	1.220	1.660	2.100	• •		•
.557	.752	.837	.773	1.005	1.024	1.048		
597.	.991	.985	.969	. 930	. 733	. 679		
.572	-667	.702	.857	. 405	.924			
.990	.440	.482	.974	.443	. 400			
.476	-571	.667	.762	. #10	. 633	. 162		
.990	.990	,989	,943	. 475	. 962	.900		
.481	.378	.676	771	- 614	- 543	.164		
.979	.970	. 776	.972	.766	. 954	. 477	454	
.440	.788	.687	.786	.035	.059	. 869	.874	
.499	.5 99	.700	.800	. 900	.930	.935	.943	.95
.950	.945	.941	.736	.927	.917	.912	. 892	
					MATC	HED INL	ET RECO	VERY
TABLEZB	NUM BER	OF +01		٠,				
0.000	.200	.400	.600	.800	1.000	1.550	1.660	2.10
.900	. 7 50	.965	.972	. 975	. 975	. 766	. 444	.41
					MATC	HED HAS	2 FLOW	
	NUMBER	DF P01	NTS .	7,		-		
TABLEZO	.600		1.000	1.220	1.660	2.100		
TABLEZ:		-1122	.740	.004	.837			
	. 722							
.400	.722		•••		8022	EXMXY	····	••••
.400	NU4PEK	ומיר אם	INYS =	6.	\$022	LIMIY		
1.248		UF PUI	NY3 = 1.060	1.000 .874	8022 2.100	LIMIT		

Figure 26. Derivative Procedure Output File (continued)

					DIST	DATION	AINTI_		. —————		
TABLEZE	MUHBER	OF POI	MTS -	A.							
.550	.700	.300	1.220	1.660	2.100						
	.572	.476	-481	.440							
					3736	TAGE ON	/ac				
								*			
HUMBER O	NUTSER F X POI		2.	2.	7.	۹,	٠.	9.	7.	7.	7.
0.000	.949	.550	.700	. 8 50	1.220	1.440			•	• •	•
0.000	1.000										
0.000	6.000										
0.000	1.000										
.286	1.361	.476	.572	.667	.481	1.000					
.181	.107	.050	-044	.002	9.000	0.000					
	.181	-476	.372	-667	.762	.857	.405	1.000			
.304	-505	-110	.054	.030	.012	.005	0.000	9.000		•	
.284	.301	.476	.572	.667	. 762	.957	.917	1.000			
.299	.306	.170	.578	.047	.021	.043	924	1.000			
.227	.146	.084	.043	.019	.004	.001	9.000	0.000			
	- 487			- 884	-: 885	1.000					
.756	.447	055.	.110	.025	0.000	0.009					
.492	.590	. 685	.786	.900	.912	1.000					
.733	.766		.553		-0.000-	_0:000					-
.500	.701	.801	.901	.936	.963	1.000					
-162	.499	.312	.125	.010	0.000	0.000					
					REFE	RENCE S	PILLAGE	DRAG			
TABLESA		OF POI	NTS =	3.							
0.000		5.100									
0.000	0.000	0.000									
					REFE	RENGE P	IASS FLO) W			
TABLESS	MINRED	OF POI	MTS -	3.	····						
0.000	1.000	2.100									
1.000		1.000									
					BOUN	DARY EI	YER BLE	ED DEAG			
											
THE LEG		Dr Xur		, ,,,,		R UP T	-FIRIDA				
0.000	.010	.850	1.226 .041	1.770	2.100						
V • U U U	0.000	- 000.0 -	0.000	- 0.000							
		0.000	0.000	0.000							
0.000	0.000										
	0.000 -007	.014	.028	.042							
0.000 0.000 0.500	.007	.014 .021	.028	.Vez		 .	·				
0.000 0.000 0.500	-007	.014	.028			······································		-		****	

Figure 26. Derivative Procedure Output File (continued)
100

					8774	SS DRAG				
TABLES.			OINTS.	7.		R OF Y-		•.		-
0.000	.849	. 850	1.000	1.220	1.440	1.770	2.320			
0.000	0.000	0.000	0.000	0.000	0.000	0.000				
0.000	0.000	0.000	0.000	0.000	0.000	0.000				
0.000	.002	-127	11.40	- 280	. 380	.700		*		
0.000	.050	.100	.154	.217	.290	.375				
0.000	.036	-075	-117	-142	.220	- 290				
0.000	. 525	.052	.047	.117	-160	-216				
0.000	.021	.044	.074	-113	.157	,215				
					SOUK	DARY LA	YER BLEE	0.0246		
TABLE64			- ETHIO		۱.					
NUMBER OF		1	:: :	2.	7.	3.	7.	₹.	6.	7.
0.000 300	.900	1.000	1.220	1.440	1.640	1.500	2.100			
0.000	0.300									
000	. 953									
0.000	0.000									
.008	.007	.005	.003	0.000						
.578	.674	.809	.867	. 164						
-014	.317	-010	-000	0.000						
.561	.481	. 834	.076	. 973						
-022	.020	.015	.012	9.900						
.031	.030	.748	.020	.014	0.000					
.594	.693	.793	.1 94	. 922	.992					
-049	-593-	.038	*054	.021	0.000					
.599	.700	. 600	. 900	. 936	1.001					
-061	.057	.051	.034	-031	0.000					
					MATC	HED 800	HOARY LA	YER BLEE	<u> </u>	
TABLEAS	HU4 BER	of POI	MTS -	۶.						
9.000	0.000	1.220	.020	.031						
										
					8464	SEAN EE	FLOW			
TABLET NUMBER T	F K POI	NTS .	OINTS -	Ł. ¨	4.	4.	٠.	4.		
0.000	1.000	1,440	1.000	1.010	£ * 140					
0.000	0.000									
0.000	1:000					····		·····		
0.000	0.900									
.389 .	.831	0.000	1.000		-		ليهي . وحد مني ، عدد مدسي		-	
	- 1887		1.555							-
.475	.010	0.000	0.000							
.390	. 8 66	.900	1.000							
.703	.014	0.000	0.000			·				
.402	.919	.934	1.000							
.334	.019	0.000	0.000							

Figure 26. Derivative Procedure Output File (continued)
101

	THLET MAP DERIVATIVE PARAMETERS	
ANNUALISK MOMBEN	PARAMETER DEFINITION	MEN_AYENE
1	ASPECT RATIO	1.0000
7	SIDEPLATE CHIBACK	
3	FIRST RAMP AMELE (DEG)	7.1000
•	DESIGN MACH MUMBER	2.1000
	COST FIR SEGMINESS	
•	TAKE OFF DOOR AREA	. 2000
7	EXTERNAL COML ANGLE(BEG)	17.5000
T T	EXIT MUZZEE TYPE FOR BLEED	1.0000
•	EXIT MOZZLE AMBLE FOR BLEED(DES)	15.0000
70	EXIT FLAP ASPECT RATES FOR BLEED	2.0000
11	CALL PLAN ANEX FOR BEEED	,1000
12	EXIT MOZZLE TYPE FOR BYPASS	1.0000
13	EXIT MOZZLE AMBLE FOR BYPASS (DEG)	15.0000
14	EXIT FEAP ASPECT WATED FOR GYPASS	2.0000
15	EXIT FLAP AREA FOR BYPASS	.2000
16	SUBSONIC DIFFUSER AREA RATTO	1.7000
17	SUBSUMIC DIFFUSER TOTAL WALL AMELETDEET	11.0000
14	SUBSONIC DIFFUSER LOSS COEFFICIENT	.1417

Figure 26. Derivative Procedure Output File (concluded)

round, convergent-divergent nozzle installation designated by File Name CD2R. This configuration and its area distribution are shown in Figure 27. The nozzle/aftbody drag characteristics for the CD2R library configuration are presented in Figure 28. $C_{\rm D}$ is presented as a function of free-stream Mach number and $A_{10}/A_9^{\rm AB}$ for a fully-expanded nozzle (P_9/P_0 = 1.0). Figure 29 shows the calculated effect of making a shape change to the nozzle/aftbody.

Figure 30 presents the old (library configuration) nozzle/aftbody derivative parameters that were used as input for the twin round convergent-divergent nozzle configuration, and Figure 31 shows the new nozzle/aft-body derivative parameter data that were used as interactive user input into the derivative procedure program. The sample interactive input used to create a new nozzle/aftbody drag map using a shape change are presented in Figure 32. Figure 33 presents the output from the TAPE6 nozzle/aftbody drag calculations which shows both the old and new aftbody drag maps resulting from the interactive session.

5.3 NOZZLE C_F DERIVATIVE PROCEDURE SAMPLE CASE

The nozzle configuration used to demonstrate the nozzle C_F derivative procedure is the round convergent-divergent nozzle configuration designated as CV1. This nozzle configuration is shown in Figure 34. Also shown plotted in Figure 34 is the baseline nozzle C_F variation as a function of nozzle pressure ratio and area ratio. These plotted data are used in table form as the old nozzle input map Figure 35. Figure 36 shows the old nozzle derivative parameters for the library nozzle. Figure 37 presents the sample interactive input commands used to create a new nozzle C_F map file which corresponds to a new nozzle divergence half-angle of 12.5 degrees. The calculated results (TAPE6 output) showing both the old and new nozzle C_F maps is presented in Figure 38. Plotted data showing the effect of changing the nozzle divergence half-angle from 11.45° to 12.5° for a nozzle area ratio of 1.60 are presented in Figure 39.

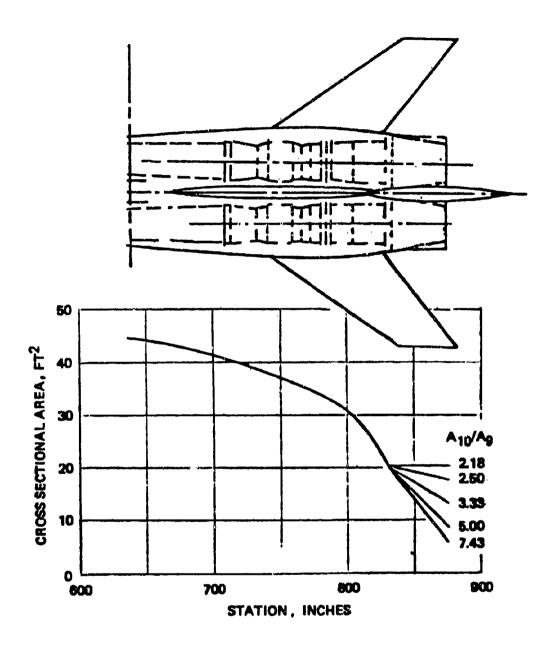


Figure 27 CD2R Nozzle/Aftbody Configuration and Area Distribution

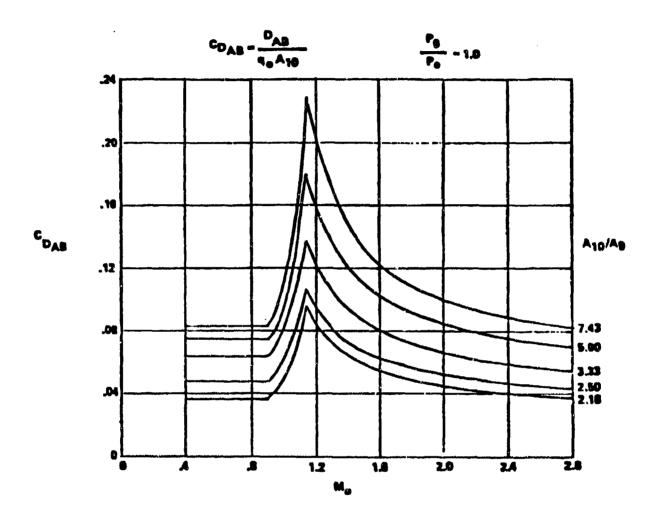


Figure 28 Nozzle/Aftbody Drag Map for Twin Round Nozzles

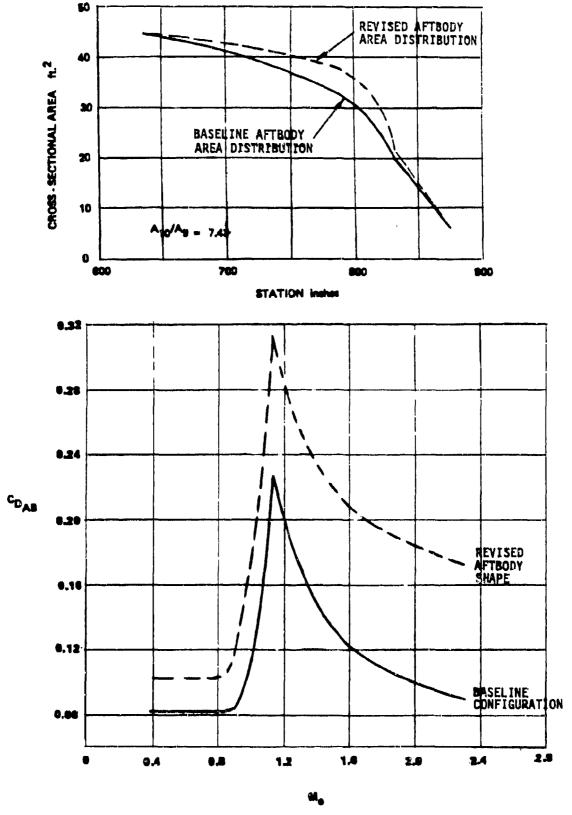


Figure 29. Comparison of New and Old Nozzle/Aftbody Drag Maps 106

					OLI	D AFTE	RBODY	MAPS	
			2R-1-R	UT-MAP					
				• • • • • • • • • • • • • • • • • • • •					
					AFT	ERBODY	DRAG T	APLE	
TABLEAB				= 9. 0 7.417	NUMBE	ER OF Y	-POINT	\$=	5.
.436	.700			0 1.400	1.600	2.000	2.30	0	······································
-037	- 037			4 .065		045	• • •	-	
•064			•	- 172 - 2 • 194			• • •	-	
•C75	. 075				.193			-	
				:143-	122		09	0	
			•				, , .		
PARAMET	P 0 41144		FERBOD	rīd qum y					N A 1 417
PARATEI	LK NUMB	167		PARAMETE	K UEFIF	ATITUM		ULU	VALUE
	<u></u>			TIC PACES					1.0300
	2	_		ONFIGURAT			· ·		2-4000
	<u> </u>			NGLE (DES) O re-and-a		TTOL R	AT10		0-3003
1	5		AREA						0.3000
THE FOLL	.0-146	ARE THE	TAPLE	S OF STAT	ION(IN)	VERSU	S AREA	(SQFT)	·
THE FOLL	.O.I46	ARE THE	TAPLE	S OF STAT	ION(IN)	VERSU	S AREA	(SQFT)	
THE FOLL	.0.146	ARE THE	TADLE	S OF STAT	ION(IN)	VERSU	S AREA	(SQFT)	
THE FOLL		ARE THE	•		A10/A9	= 2	S AREA	(SQFT)	
	TABLE	NUMBER	= .1	MCITAT2-	A10/A9	= 2 E4	.18		25,00
	TABLE	NUMBER	= .1	STATION	A10/A9 - AND AS 36.00 E	= 2 35.60.00	.18		25.00
637.06	TABLE 44.50 20.50	NUMBER 700.00 876.00	= 1 41.50 20.50	STATION 760-00	A10/A9 AND AF 36.00 E	= 2 360.00	.18		25.00
637.06	TABLE 44.50 20.50	NUMBER 700.00	= 1 41.50 20.50	STATION 760-00	A10/A9 AND AS 36.00 E	= 2 300.00	.18		25.00
637.05 830.00	TABLE 49.50 20.50 TABLE	NUMBER 700.00 876.00 NUMBER	= 1 41.50 20.50 = 2	STATION 760.00	A10/A9 AND AF 36.00 E A10/A9 AND AF	= 2 REA 300.00 = 2 REA	.18 31.90	820.00	· · · · · · · · · · · · · · · · · · ·
637.05 830.00	TABLE 44.50 20.50 TABLE	NUMBER 700.00 876.00 NUMBER	= 1 41.50 20.50 = 2	STATION 760-00 STATION	A10/A9 AND A5 36.00 E A10/A9 AND A6	= 2 REA 300.00 = 2 REA	.18 31.90	820.00	· · · · · · · · · · · · · · · · · · ·
637.05 830.00	TABLE 44.50 20.50 TABLE 20.50	NUMBER 700.00 876.00 NUMBER 700.00 876.00	= 1 41.50 20.50 = 2 17.64	STATION 760.00 STATION	A10/A9 AND AS 36.00 E A10/A9 AND AR	= 2 960.00 = 2 REA	.18 31.90 .50	820.00	· · · · · · · · · · · · · · · · · · ·
637.05 830.00	TABLE 44.50 20.50 TABLE 20.50	NUMBER 700.00 876.00 NUMBER 700.00	= 1 41.50 20.50 = 2 17.64	STATION 760-00 STATION	A10/A9 AND AS 36.00 E A10/A9 AND AS 36.60 G	= 2 300.00 = 2 REA	.18 31.90	820.00	· · · · · · · · · · · · · · · · · · ·
637-06 837-00 687-06 830-60	TABLE 44.50 20.50 TABLE 44.53 20.50 TABLE	NUMBER 700.00 876.00 NUMBER 700.00 876.00	= 1 41.50 20.50 = 2 41.56 17.64	CITATE OC. DO TO	A10/A9 AND AS 36.00 E A10/A9 AND AS A10/A9 AND AS	= 2 300.00 = 2 REA	.18 31.90 .50 -31.90	820-00	25.00
637-06 837-06 837-06 837-06	TABLE 44.50 20.50 TABLE 44.50 TABLE	NUMBER 700.00 876.00 NUMBER 700.00 876.00	= 1 41.50 20.50 = 2 17.64 = 3	STATION 760-00 STATION 760-03	A10/A9 AND AS 36.00 E A10/A9 AND AS A10/A9 AND AS	= 2 300.00 = 2 REA	.18 31.90 .50 -31.90	820-00	25.00
637-06 837-06 837-06 837-06	TABLE 44.50 20.50 TABLE 44.50	NUMBER 700.00 876.00 NUMBER 700.00 876.00	= 1 41.50 20.50 = 2 17.64 = 3 41.50	STATION 760.00 STATION STATION 760.00	A10/A9 AND AF 36.00 E A10/A9 AND AF 36.00 E	= 2 300.00 = 2 REA 300.00	.18 31.50 .50 31.30	820-00	25.00
637-06 837-06 837-06 837-06	TABLE 44.50 20.50 TABLE 44.50	NUMBER 700.00 876.00 NUMBER 700.00 876.00	= 1 41.50 20.50 = 2 17.64 = 3 41.50	STATION 760.00 STATION 760.00	A10/A9 AND AF 36.00 E A10/A9 AND AF 36.00 E A1C/A9 A1C/A9	= 2 300.00 = 2 300.00	.18 31.90 .50 -31.90	820-00	25.00
637-06 830-00 637-06 930-60	TABLE 44.50 20.50 TABLE 44.50 44.50 30.50	NUMBER 700.00 876.00 NUMBER 700.00 876.00 HUMBER 700.00	= 1 41.50 20.50 = 2 17.64 = 3 41.50 = 4	STATION 760.00 STATION 760.00 STATION	A10/A9 AND AR A10/A9 AND AR ACCOC A1C/A9 AND AR A1C/A9	= 2 300.00 = 2 3EA 300.00	.18 31.90 .50 31.90 .33	820.00 820.00	25.00
637-06 830-00 637-06 930-60	TABLE 44.50 20.50 TABLE 44.50 TABLE 44.50 TABLE	NUMBER 700.00 876.00 NUMBER 700.00 876.00 HUMBER 700.00	= .1 41.50 20.50 = 2 17.84 41.50 41.50	STATION 760.00 STATION 760.00	A10/A9 AND AR A10/A9 AND AR ACCOC A1C/A9 AND AR A1C/A9	= 2 300.00 = 2 3EA 300.00	.18 31.90 .50 31.90 .33	820.00 820.00	25.00
637.00 837.00 637.00 848.00	TABLE 44.50 20.50 TABLE 44.50 20.50 TABLE 44.50 20.50	NUMBER 700.00 876.00 NUMBER 700.00 876.00 MUMBER 700.00 MUMBER 700.00	= 1 41.50 20.50 = 2 17.84 = 3 41.50 13.15 = 4 41.50 8.92	STATION 760.00 STATION 760.00	A10/A9 A10/A9 A10/A9 AND AR A10/A9 AND AR 36.00 E	= 2 360.00 = 2 354 300.00 = 5	.18 31.90 .50 31.90 .00 31.90	820.00 820.00	25.00
637.00 837.00 637.00 848.00	TABLE 44.50 20.50 TABLE 44.50 20.50 TABLE 44.50 20.50	NUMBER 700.00 876.00 NUMBER 700.00 876.00 HUMBER 700.00	= 1 41.50 20.50 = 2 17.84 = 3 41.50 13.15 = 4 41.50 8.92	STATION 760.00 STATION 760.00	A10/A9 AND AR A10/A9 AND AR A10/A9 A10/A9 A10/A9 A10/A9	= 2 300.00 = 2 REA 300.00	.18 31.90 .50 31.90 .33	820.00 820.00	25.00

Figure 30. Old Nozzie/Aftbody Derivative Parameters

Figure 31. New Nozzle/Aftbody Derivative Parameters

DERIVATIVE PROCEDURE PROGRAM

ENTER CODE FOR MAPS TO BE CHANGED

- FOR INLET MAP CHANGES
- FOR NOZZLE/AFTBODY CHANGES
- 3 FOR CV MAP CHANGES

1>2

CD2R INPUT MAP

ENTER CODE FOR DUTPUT DESIRED

- O FOR TAPES DUTPUT DNLY
- 1 FOR TAPES DUTPUT AND TAPE1 (NEW PIPSI) FILE

I >1

AFTERBODY TYPE = CD-AXISYMMETRIC DUAL NOZZLE

AFTERBODY MAP DERIVATIVE PARAMETERS

	in this man in the second in the strictly of the second	
PARAMETER NUMBER	PARAMETER DEFINITION	OLD VALUE
1	NOZZLE STATIC PRESSURE RATIO	1.0000
2	TAIL FIN CONFIGURATION	2.0000
3	TAIL FIN ANGLE(DEG)	0.0000
4	TAIL FIN FORE AND AFT LOCATION RATIO	.1736
5	BASE AREA RATIO	0.0000

INPUT NUMBER OF PARAMETERS TO BE CHANGED

1>0

PRE DERIVATIVE PARAMETERS CORRECT(0=YES 1=NO)

I >0

THE FOLLOWING ARE THE DLD TABLES(STATION(IN) VERSUS AREA(SQFT)) ASSOCIATED WITH A PARTICULAR A10/A9 THE USER MAY CHANGE A TABLE VALUE FOR A PARTICULAR A10/A9 RATID

> TABLE NUMBER = 1 A10/A9 = 2.18

STATION AND AREA

637.00 44.50 700.00 41.50 760.00 36.00 800.00 31.00 820.00 25.00

830.00 20.50 876.00 20.50

TABLE NUMBER = 2 A10/A9 = 2.50

STATION AND AREA

637.00 44.50 700.00 41.50 760.00 36.00 800.00 31.00 820.00 25.00

830.00 20.50 876.00 17.84

Floure 32. Sample Interactive Input for Creating a New Nozzle/Aftbody Drag Map 109

A10/A9 = TABLE NUMBER = 3 3.32 STATION AND AREA

637.00 44.50 700.00 41.50 760.00 36.00 800.00 31.00 820.00 25.00 830.00 20.50 876.00 13.39

> TABLE NUMBER = 4 A10/A9 = 5.00 STATION AND AREA

637.00 44.50 700.00 41.50 760.00 36.00 800.00 31.00 820.00 25.00 830.00 20.50 876.00 8.92

> TABLE NUMBER = 5 A10/A9 = 7.43 STATION AND AREA

637.00 44.50 700.00 41.50 760.00 36.00 800.00 31.00 820.00 25.00 6.00 830.00 20.50 876.00

DO YOU WISH TO CHANGE A TABLE (0=NO 1=YES)

1>1

ENTER THE TOTAL NUMBER OF TABLES TO BE CHANGED I > 1

ENTER THE CORRESPONDING NUMBERS OF THE TABLES TO BE CHANGED

1)5

HOW MANY POINTS ARE IN YOUR NEW TABLE

1)7

INPUT THE POINTS IN PAIRS(STATION(IN), AREA(SQFT))

1>637. 44.5 700. 43. 760. 40. 800. 36. 820. 30. 830. 22. 876. 6.

THE FOLLOWING ARE THE NEW TABLES(STATION(IN) VERSUS AREA(SQFT)) ASSOCIATED WITH A PARTICULAR A10/A9 THE USER MAY CHANGE A TABLE VALUE FOR A PARTICULAR A10/A9 RATIO

> TABLE NUMBER = 5 A10/A9 = 7.42 STATION AND AREA

637.00 44.50 700.00 43.00 760.00 40.00 800.00 36.00 820.00 30.00 830.00 22.00 876.00 6.00

ARE TABLES CORRECT(0=YES 1=NO) 1>0

DO YOU WISH TO CHANGE THE DEFRULT A9A8 SCHEDULE(0=NO 1=YES)

1>0

DERIVATIVE PROCEDURE PROGRAM

ENTER CODE FOR MAPS TO BE CHANGED

- FOR INLET MAP CHANGES
- FOR NOZZLE/AFTBODY CHANGES
- FOR CY MAP CHANGES 3

I>"END"

Figure 32. Sample Interactive Input for Creating a New Nozzle/Aftbody Drag Map (concluded) 110

OLD AF	TEREODY.	MAPS
--------	----------	------

			A 300 Mar des 200	0-54 -		•
			AFTER	DUUT D	RAG TABLI	:
ABLEAR NUME	ER OF X-POINTS:	= 9.	NUMBER	OF Y~	PCINTS=	5•
- 2 6 1 5 0 - 2 6 5 B	ម) 76417 -				
-43.0 -90	0 1.130 1.20	1.400	1-600	2.000	5 - 2 0 0	
	7 1096 +984					
-054 -06	0 - +107 - +59 5		- 081	- 056	-063	
.075 .07	+ .138 .1225 .186 .158	120	-103	-365	-077	
	3 - 6228 - 624					
	_				1.0	
ADABETED AUIN	AFTERBOD1 Ber					OLD WELLE
ARABEIER NUM	DER	FARADETE	N DEFINI	1104	'	JED VALUE
	NOZZLE STAT	r ic Press i	URE RATI			
2	TAIL FIN CO			*		2.0000
3	TAIL FIN AN			· · ·		0-2000
<u> </u>	TAIL FIN FO		T-LOCAT	ION RA	7.0	1736
5	BASE AREA F	MIIO				0.0000
TABL	E NUMBER = 1	ļ	A10/A9 =	2.	18	
37.03 44.50	700-00 41-50 876-00 20-50	760-00 .3	36.00 60	0.00	3130 82	0.00 25.00
	<u> </u>					
IABL	E NUMBER = 2		= Alo/A9 And are		5 0	
		760 600	** ** **		<u> </u>	
 37400 44450			DE RANGE OF	0.00	03400 BE	LESC STEDS
37.00 44.50 30.00 20.50	876-00 17-84		3 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 -	0 0 0	0 1 40 0 - <u>0 2</u> 1	1856 53800
37.00 44.50 30.00 20.50	876.00 17-84				7.7	23200
37.00 44.50 30.00 20.50 TABL	876-00 17-84 C-NUNDER = 3		A10/A3 =	3,	3-3	1846 23800
30.00 20.50 TABL	876.00 17-84 C-NUNDER = 3	STATION	A1G/A3 - AND ARE	3 ·	3-3	
I A . A	875-00 17-84 E NUMBER = 3 700-00 41-50	STATION 760-00	A10/A3 = AND ARE 36.00 80	A J.60	33 31.00 82	
37.00 44.50	875-00 17-84 E NUMBER = 3 700-00 41-50	STATION 760-00	A10/A3 = AND ARE 36.00 80	A J.60	33 31.00 82	
37.00 44.50	876.00 17-84 E NUMBER = 3 700.00 41.50 070.00 17.07 E NUMBER = 4	STATION 760-00	A10/A3 = AND ARE 36.00 80	A 3.60	33.00 82	
30.00 20.53 TABL 37.00 44.50 50.01 20.55	876.00 17-84 E NUMBER = 3 700.00 41-50 670.50 17-37 E NUMBER = 4	STATION 760-00	A10/A3 = AND ARE 36.00 80 A10/A9 =	A 3.00	33.00 82	0.00 25.00
37.00 44.50 TABL 37.00 44.50	875.00 17-84 E NUMBER = 3 700.00 41.50 676.50 17.37 E NUMBER = 4 700.00 41.50	STATION 760-00	A10/A3 = AND ARE 36.00 80 A10/A9 =	A 3.00	33.00 82	0.00 25.00
37.00 44.50 TABL 37.00 44.50 50.00 20.50 TABL 20.50 20.50	876.00 17-84 E NUMBER = 3 700.00 41-50 670.50 17-37 E NUMBER = 4	STATION 760-00 STATION 760-00	A10/A9 = AND ARE 36.00 80 A10/A9 = AND ARE 36.00 80	A 3.00 5.	33.00 820 31.00 820 30 31.00 820	0.00 25.00

Figure 33. Output from Nozzle/Aftbody Drag Map Calculation

_	 C 3	-14	IPII.	<u> </u>	44

AFTERBODY DRAG TABLE

	NUMBER				NUMEE	R OF Y-	FOINTS=	5.	
-400 -037	.500 .500	1.130	1.200	1.400 .065	. 255	- 045	-642		.55
.048 .064 .075	• 364 • 075	-138 -180	.158	. 394 .120	.081 .183	• 353 • 365 • 085	.060 .077		
·205		+514	*26.6	FE3+		- + 1 th	- 176		

,	2.18C	3.926	5.571	701NTS	
	-400	-875	1.350	1.825	
		1.000 0.000	1.500 105	-2.503 210	
	-114	0.050	114	227	
	-0158 -015	000	015	030	and the state of t
	-002	0.000	002	004	• - • 0.09 (1.56) (1.56) (1.56) (1.56) (1.56)
	- +535 -039	263.3- 030.c	336	-•077	
	-023	0.300	C23	847	
	- e à à 5	- 0. 300			しょうなき 前 「「」」「「中国の子」と、「大田が大きないと、「「「「「」」」「「「」」「「」」「「」」「「」」「「」」「「」」「「」」「
· .	-001		0C1	401	
	-024	. 6.600	024	048	
	.016	0.000		031	
	.003	636		C07	
	500b	0.000	- 1000	*****	
•	.D24	000			
	1025	0.008 0.000	C26	051	
	.003	0.856		007	
	-80°C	000		001	

AFTERBODY HAP DERIVATIVE PARAMETERS

PROPERTY OF THE PROPERTY OF TH		
1	NOZZLE STATIC PRESSURE RATIO	1.0000
	TAIL FIN CONFIGURATION TAIL FIN ANGLETTEG A TAIL FIN FORE AND AFT LOCATION RATIO	2.0000 S.0000
	BASE AREA RATTO	4.00 0

THE PERSON AND PROPERTY.

THE POL. Out NO ARE THE PAGEES OF STATION(IN) VERSUS AREA(GOFT)
Figure 33: Surput Tran Nozzle/Afthody Drug Map Celculation (continued)

		NUMBER	•	A10/A5 = 2.18 STATION AND APEA	
850-C3		876.00	20.56	760a05 36a60 800a00 31a00 020ab0 25a0u	
	TABLE	- NUMBER	v 2	A10/A5 = 2×50	
637.60	44 4 5 4	700.00	41.55	STATION AND AREA 760.00 36.00 800.00 31.00 820.00 25.00	
830466		. 76. 56			
····	TABLE	NUMBER	= 3	A10/A9 = 3.33	
637.CS 830.00		700.00 676.00	41.50 13.39	760.00 36.00 800.00 31.00 820.00 25.00	
	TABLE	NUMBER	= . 4	A10/A9 = 5.00 STATION AND AREA	
637.30 630.33		876-90	*1.55 8.92	760.00 34.30 800.00 32.00 620.30 25.00 -	
	- 143LE	NUMEER		A10/A5 - 70+0-	
637.50	AA . 5.0	790.00	AX. CC	TATION AND AREA : 760.00 40,00 800.00 36.00 820.00 30.00	
		- 676**8			
					-
			•		
			• •		
		· ·	:		<u></u>
Fi	gure 33.	Output	from N	ozzle/Afthody Drag Map Calculation (concluded)	
F1	gure 33.	. Output	from N	ozzle/Aftbody Drag Map Calculation (concluded)	
F1	gure 33.	. Output	from N	ozzle/Aftbody Drag Map Calculation (concluded)	
Ff	gure 33.	. Output	from N		er e
F1	gure 33.	. Output	from N		\$145) XX
F1	gure 33.				\$1 % %
Fí	gure 33.		from N		
F1	gure 33.				
F1	gure 33.				
F1	gure 33.				
F1					
F1	gure 33.				
F1					

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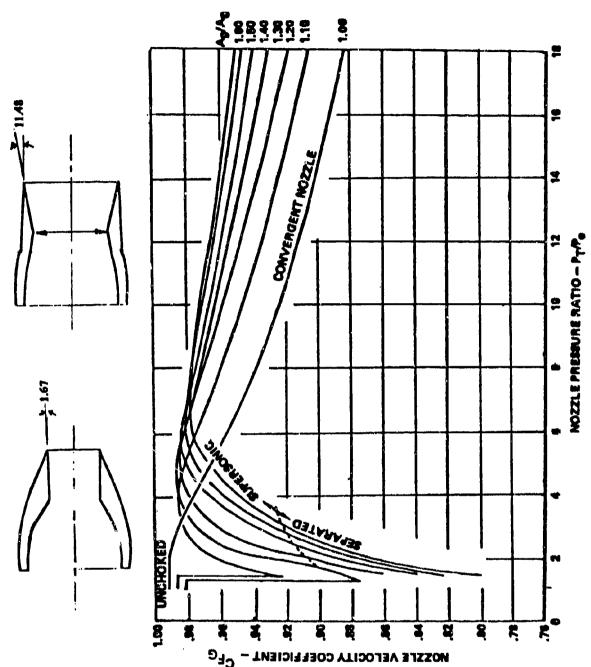


Figure 34. Gross Thrust Coefficient for a Round C-D Nozzle

		-			üLD	CFG	H/	PS	
		CV1	INPUT-	MAP			·····		
					CFG	TABLE			
BLECV		OF X-P		10.			-POINTS	. 7	•
1.500	2.000 .792	3.000	4.000 -976	5.000 -766	6 - 000 - 755	.934	.924	14.000	.886
.888 .862	•935 •905	.977	.986 .982	.988 .986	.783 .782	.970 .972	.958 .964	.925 .938 .947	.920 .932
-840 -822 -800	-876 -867	.932 .922	.962 .952	•977 •970	-982 -979	.976 .978 .478	.970 .972	.954 .959 .961	.946 .952
RANETE	R NUMBE	CFG			IVATIVE R DEFIN		ETERS	OLD VA	ur
1		-		IALF ANG					-4500
		Fig	ure 35	. 01d	l Nozzl	e C _{FG}	Input	1ap	
		Fig	ure 35	. 01d	Nozzle	e C _{FG}	Input	1 ap	
		Fig	ure 35	. 01d	l Nozzlo	e C _{FG}	Input	1 ap	
		Fig	ure 35	. 01d	l Nozz1	e C _{FG}	Input	1 ap	
		Fig	ure 35	. 01d	l Nozzlo	e C _{FG}	Input !	1ap	
		Fig	ure 35	. 01d	l Nozz1	e C _{FG}	Input !	Чар	
		Fig	ure 35	. 01d	l Nozz1	e C _{FG}	Input	1 ap	
		Fig	ure 35	. 01d	l Nozz1	e C _{FG}	Input !	1 ap	

NOZZLE TYPE = ROUND CONVERGENT-DIVERGENT NOZZLE
CFG MAP DERIVATIVE PARAMETERS
PARAMETER NUMBER PARAMETER DEFINITION
1 DIVERGENCE HALF ANGLE(DEG)

DLD VALUE

Figure 36. Old Nozzie Derivative Parameters

DERIVATIVE PROCEDURE PROGRAM

ENTER CODE FOR HAPS TO BE CHANGED

FOR INLET HAP CHANGES

FOR HOZZLE/AFTBODY CHANGES

FOR CY MAP CHANGES 3

1>3

CVI INPUT HOP

ENTER CODE FOR DUTPUT DESIRED

O FOR TAPES DUTPUT DNLY

1 FOR TAPES OUTPUT AND TAPES (NEW PIPSS) FILE

1>1

NDZZLE TYPE = ROUND CONVERGENT-DIVERGENT HDZZLE CFG MAP DERIVATIVE PARAMETERS

PARAMETER NUMBER PARAMETER DEFINITION

OLD VALUE DIVERGENCE HALF ANGLE(DEG) 11.4500

INPUT NUMBER OF PARAMETERS TO BE CHANGED

1>1

INPUT THE PARAMETERS TO BE CHANGED FOLLOWED BY THE NEW VALUE IN PAIRS(PARAMETER NUMBER NEW VALUE)

121 12.5

PARAMETER NUMBER PARAMETER DEFINITION DIVERGENCE HALF ANGLE(DEG)

NEU VALUE 12.5000

ARE THE DERIVATIVE PARAMETERS CORRECT(D=YES 1=ND)

1>0

DERIVATIVE PROCEDURE PROGRAM

ENTER CODE FOR MAPS TO BE CHANGED

FOR INLET MAP CHANGES

FOR NOZZLE/OFTBODY CHANGES

FOR CV MAP CHANGES

I>"END"

Figure 37. Sample Interactive Input for Creating a New Nozzle CFc Map

						CF6	***	IPS	
		evi	_tmut_						
	,				CF6	TABLE			·
TABLECY		0F X-P			- wunde				•
1.500		3.000	4.000	5.111	-1-884- 6-808			14.000	10.00
.972	.772	.786	.976	-166	.955	.734	.924	.943	-866
	968			.766		.978			-92(
-162	.705	-965	.782	-786	"982	.972	.964	.947	-731
	440					874_		J \$4_	844
.822 .101	.876 .867	.732	.742 .732	.977 .978	-962 -979	.978 .978			.746
			_		IVATIVE				
PARAMETE	a MUNEC	<u> </u>		MARAETE	a berin	IIION		OLD NA	LUE
1		EIVER	GENCE H	ALF AND	LE (DE0)			11	.4588
·					461	CF8	e.	APS	
		cv1	INPUT		461	CF6	Q	APS	
		EV3	INFUT	***		CF6	Q	APS	
		OF X-P	POINTS	10.	cye cye	TABLE R OF V	-POINTS:		7.
		OF X-P	= 2.7%10°	18.	CF8	TABLE R OF V	-POINTS:	14.000	
	2.066	OF X-P	POINTS= 1.385 4.860 .976	18. 1.488 3.888	CF8 . NUMBE 4.038 6.098 .998	TABLE R OF V 1.603 4.006	-POINTS:	14-000	18.00
1.586	2.066 .992	OF X-P	POINTS= 1.385 4.880 .976	18. 4.44. 5.88. 5.96. -766.	CF8 . NUMBE	TABLE R OF V 1.603 4.086 -938	-POINTS:	14.000	18.00
1.586 .992 .887	2.068 .972 .968	OF X=P 1-208 3-066 -966 -976	POINTS= 1.385 4.880 .976 .985	18. 1.444 3.886 -746 -987	CF8	TABLE R OF V 1.663 4.086 -948	-POINTS: 19.881 .924 .947	14-000 -903 -925 -937	18.00 -86
1.586	2.066 .992	OF X-P 3-208 3-060 -966 -976 -976	POINTS= 1.385 4.860 .976 .985 .981	18. 1.48. 3.888 .946 .987 .987	CF6 4-510 6-898 -953 -953 -962 -981	TABLE R OF V 1.6C3 4.086 -938 -948 -949	-PCINTS: 19-889 -924 -947 -957 -963	14.000 .903 .925 .937 .746	18.00 -86
1.500 1.500 .992 .887 .861	2.066 .772 .865 .734 .764	OF X-P 1-208 3-006 -986 -976 -964 -945	OINTS= 1.38 4.88 .976 .985 .985 .781	18. 1.48. 3.88. .946 .987 .987 .981	Cys . NUMBE . 1939 . 1939 . 1939 . 1939 . 1982 . 1983 . 1989	TABLE R OF V 1.603 4.086 .938 .949 .971	-POINTS: 19.009 .924 .947 .957 .963	14.000 .983 .925 .937 .946	18.00 -86
1.500 1.500 .992 .807 .861	2.066 .772 .865 .754 .764	OF X=P 3-086 -986 -986 -976 -964	OINTS= -1.38 -1.80 -776 -785 -785	18. 1.488 3.888 .966 .963 .987 .985	Cys . NUMBE . 1939 . 1939 . 1939 . 1939 . 1982 . 1983 . 1989	TABLE R OF V 1.603 4.086 -938 -949 -971	-POINTS: 19.889 .924 .947 .957 .963	14.000 .983 .925 .937 .946	18.00 -06
1.500 1.500 .992 .887 .861	2.066 .772 .865 .734 .764	0F X=F 1-288 3-066 -986 -986 -976 -964 -938 -919	POINTS= -1.38 -1.880 -776 -781 -781 -764 -764 -769	18. 1.488 3.888 -946 -943 -943 -985 -975 -975	CF6 MURBE 1-510 6-898 -953 -953 -962 -981 -980 -976	TABLE R OF V 1.6C3 4.086 -938 -948 -949 -971 -978	-PCINTS: 19-889 -924 -947 -957 -963 -966 -948	14.000 .983 .925 .937 .946	18.00 -06
1.500 1.500 .992 .807 .861 .620 .797	2.066 .772 .065 .754 .704 .874 .864	OF X-P 1-208 3-106 -966 -956 -964 -938 -919	OINTS: 1.38 4.88 .976 .985 .985 .985 .964 .964	18. 1.480 3.880 .966 .967 .987 .981 .975 .967	Cys . NUMBE . 1939 . 1939 . 1939 . 1939 . 1982 . 1983 . 1989	TABLE R OF V 1.603 4.086 -938 -949 -971 -976 -978	-POINTS: 19-881 -924 -947 -947 -963 -968 -969	14.000 .983 .828 .937 .946 .958 .957	18.00 .06 .71 .73 .74 .74
1.500 1.500 .992 .887 .861	2.068 .792 .665 .794 .794 .874 .864	OF X-P 3-200 -986 -986 -976 -964 -938 -919	POINTS: 1.38 4.88 4.76 .776 .785 .781 .760 .760	18. 1.400 3.800 .946 .947 .985 .975 .967	CFE - NUMBE	TABLE R OF V 1.603 4.086 -938 -949 -971 -978 -978	-POINTS: 19-881 -924 -947 -947 -963 -968 -969	14.000 .983 .937 .946 .958 .958	18.00 .06 .71 .73 .74 .74

Figure 38. Terminal Output for Nozzle $C_{\mbox{\scriptsize FG}}$ Map 118

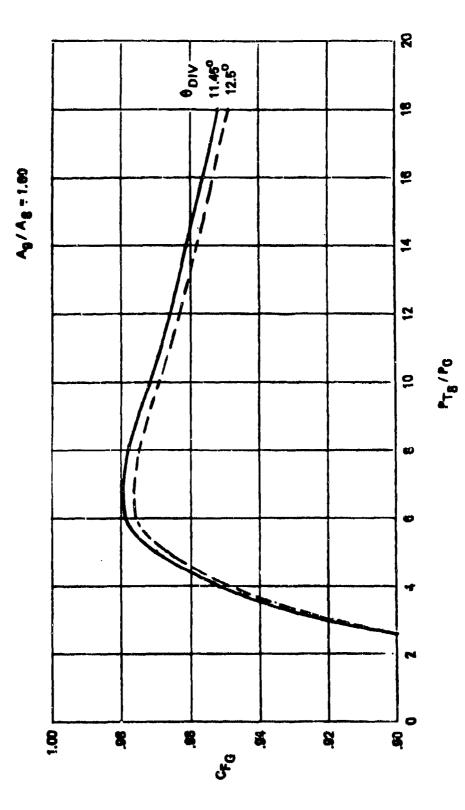
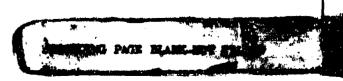


Figure 39. Effect of Change in Divergence Half-Angle on CFg of a Round C-D Nozzle

SECTION VI

This section presents the engineering flow charts used to develop the derivative procedure computer program. Section 6.1 presents the inlet derivative procedure flow charts, Section 6.2 presents the nozzle/aftbody drag derivative procedure flow charts, and Section 6.3 presents the nozzle gross thrust coefficient derivative procedure flow charts.



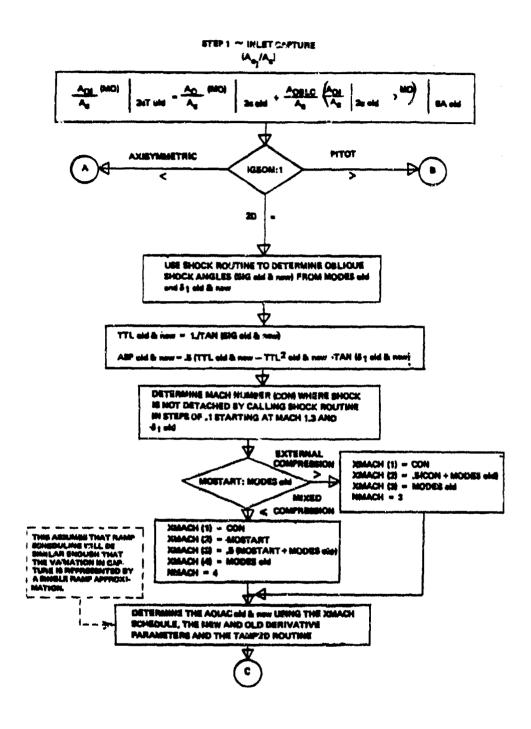


Figure 40. Flow Chart for Step 1

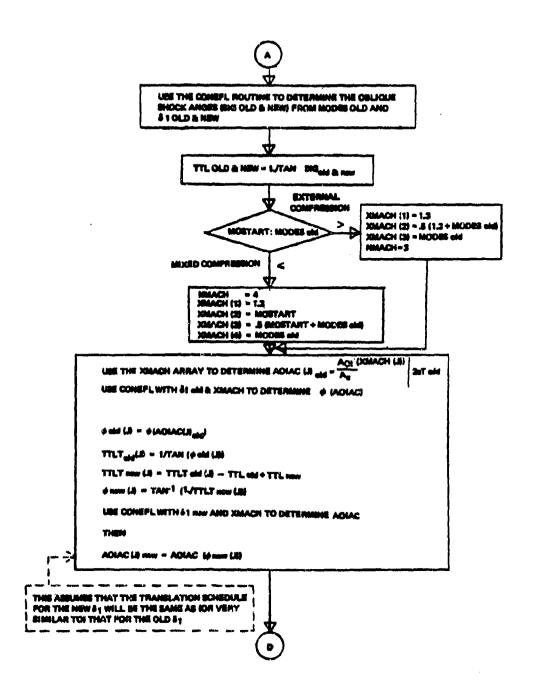


Figure 40, Flow Chart for Step 1 (cont'd)

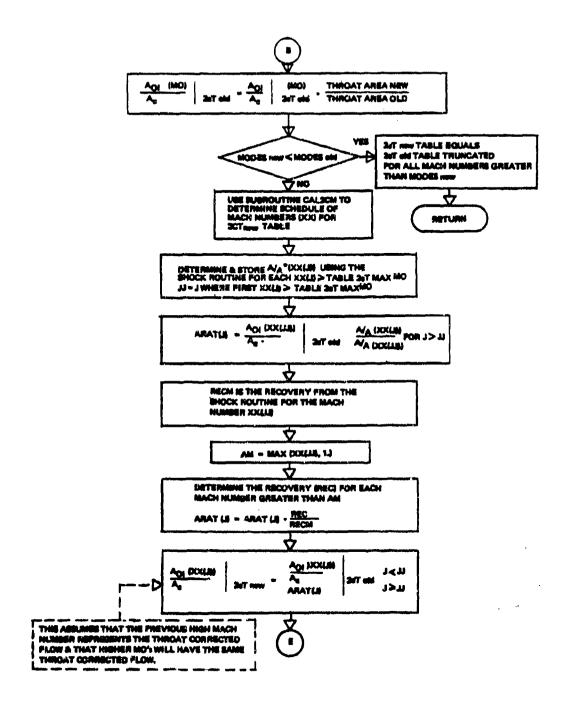


Figure 40. Flow Chart for Step 1 (cont'd)

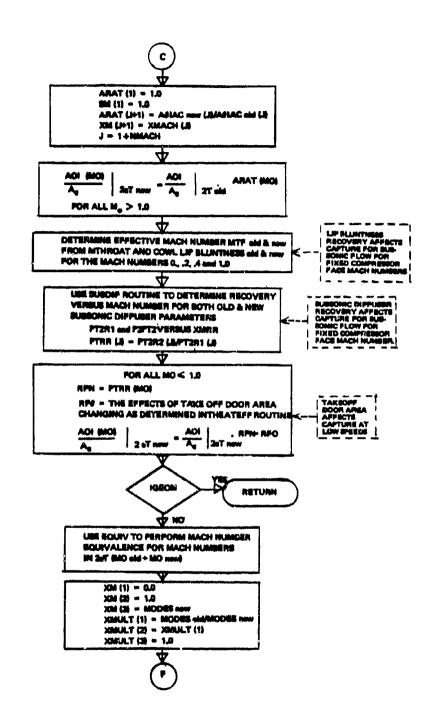


Figure 40, Flow Chart for Step 1 (cont'd)

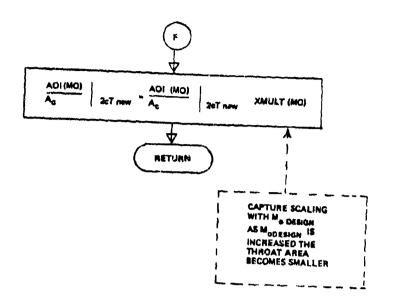


Figure 40, Flow Chart for Step 1 (concluded)

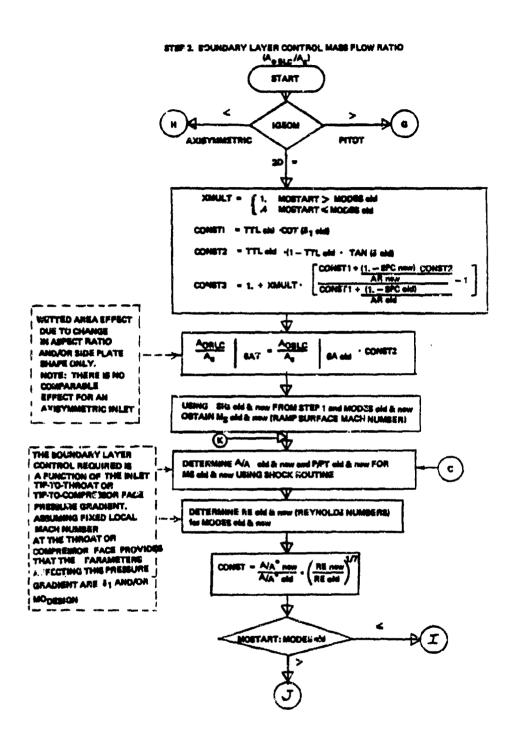


Figure 41. Flow Chart for Step 2

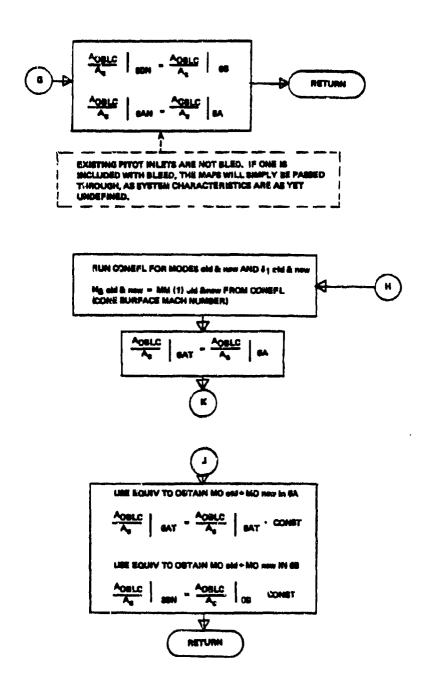
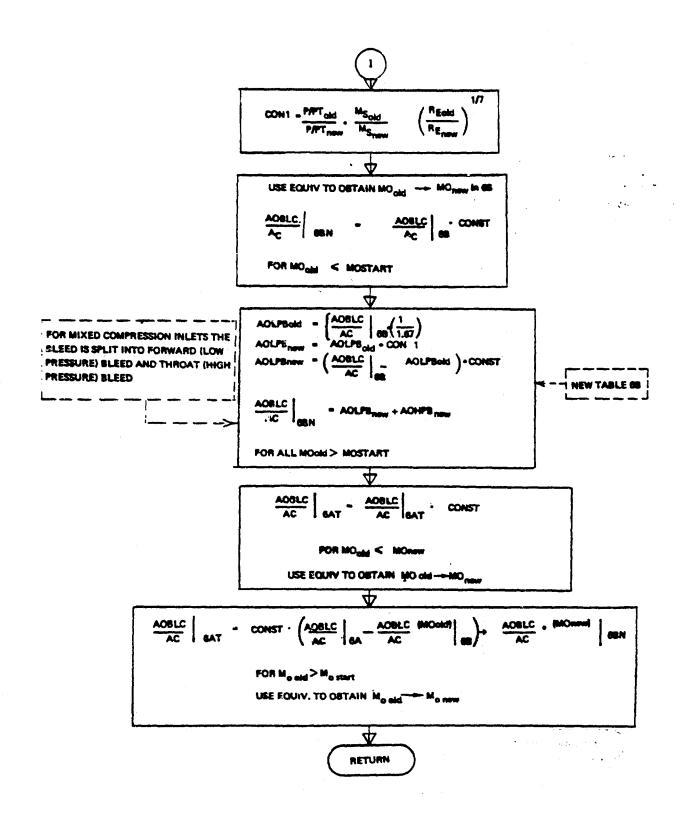


Figure 41. Flow Chart for Step 2 (cont'd)

The second second



Pigure 41, Flow Chart for Step 2 (concluded)

and the second s

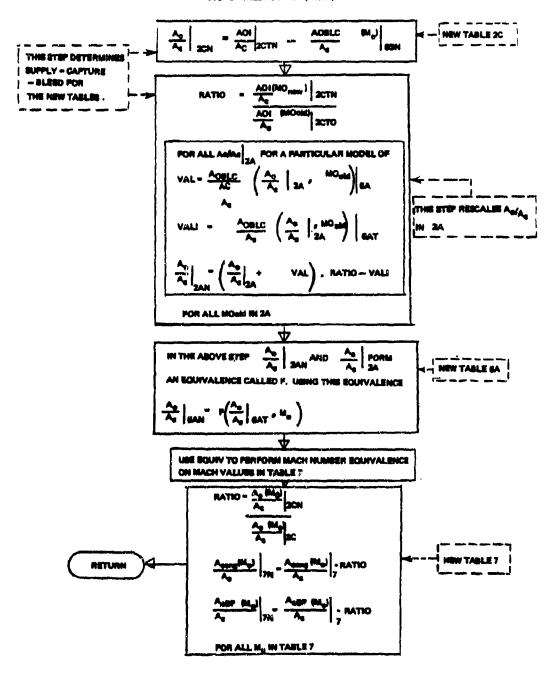


Figure 42. Flow Chart for Step 3

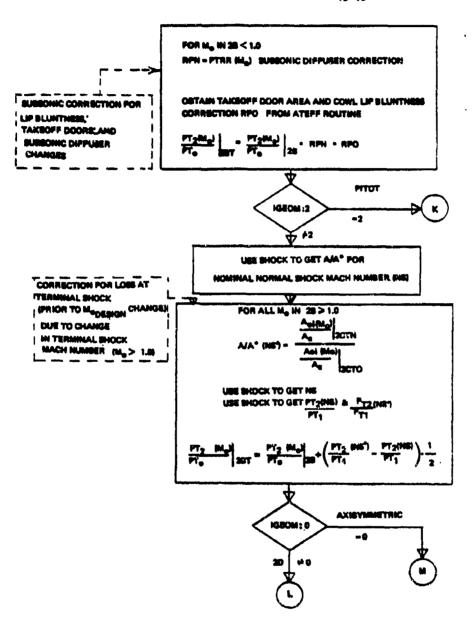


Figure 43. Flow Chart for Step 4

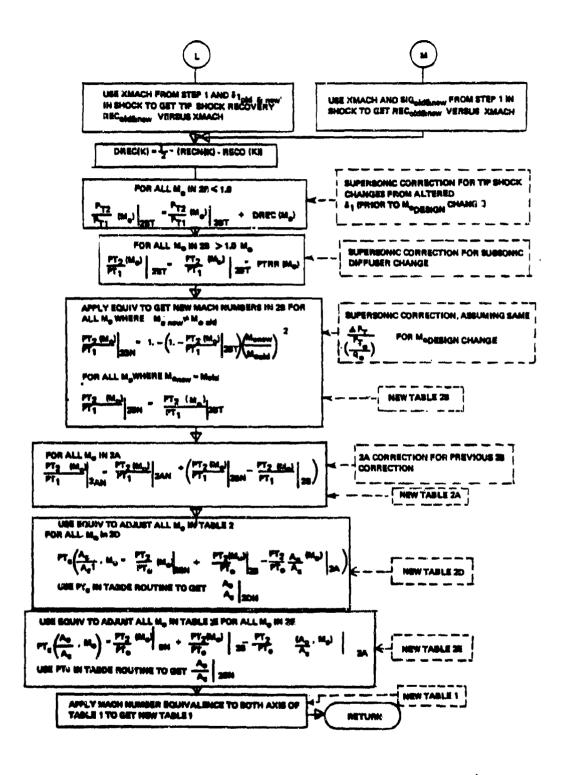


Figure 43, Flow Chart for Step 4 (concluded)

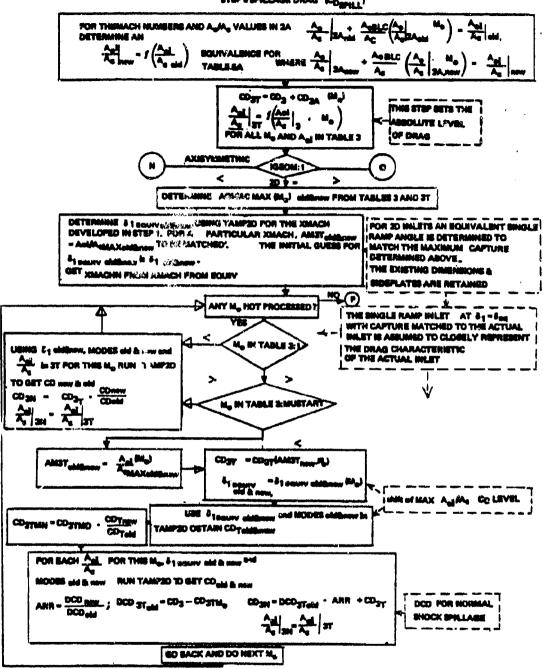


Figure 44. Flow Chart for Step 5

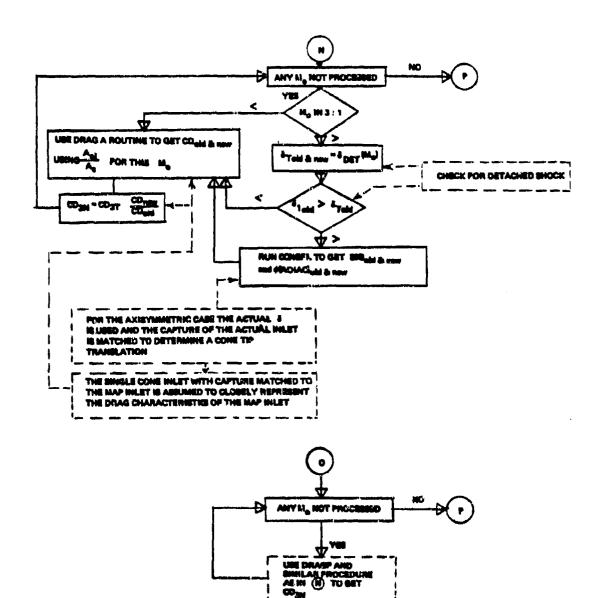


Figure 44. Flow Chart for Step 5 (cont'd)

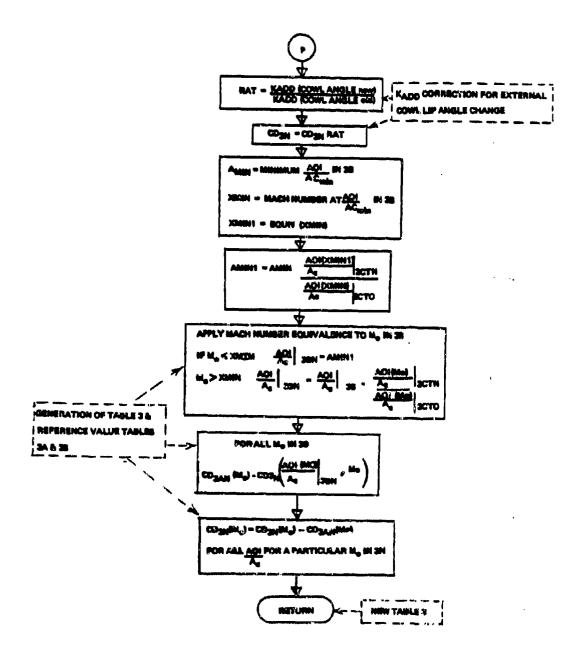


Figure 44, Flow Chart for Step 5 (concluded)

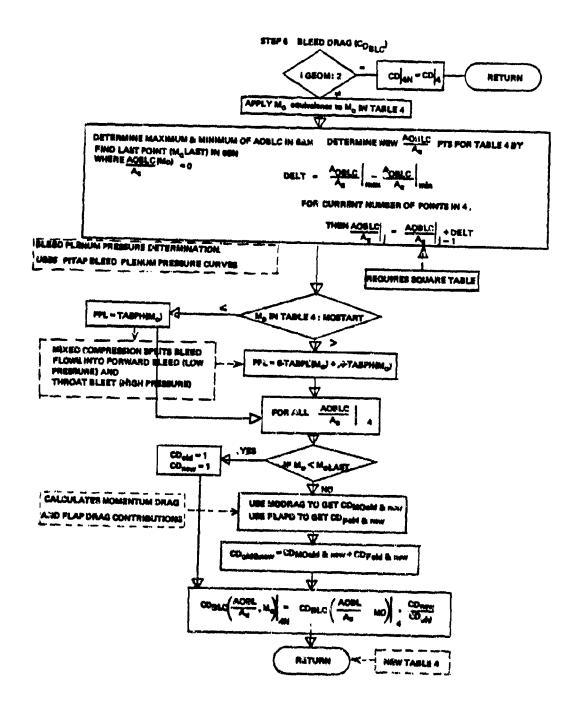


Figure 45. Flow Chart for Step 6

The second section is a second section of the second section in

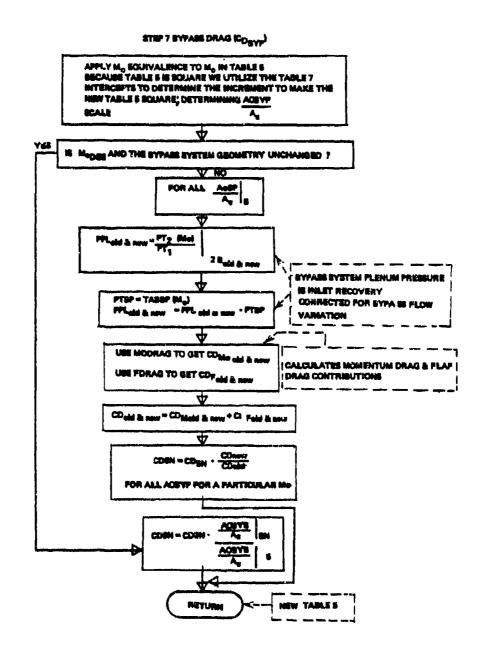


Figure 46. Flow Chart for Step 7

The state of the s

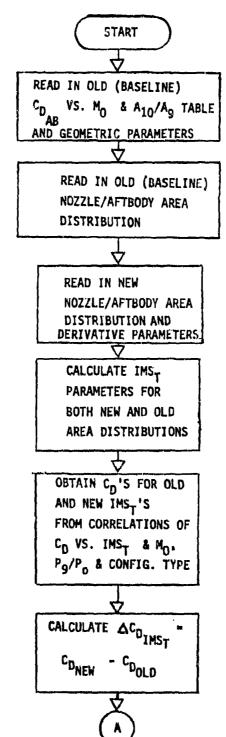


Figure 47. Flow Chart for Nozzle/Aftbody Drag Procedure

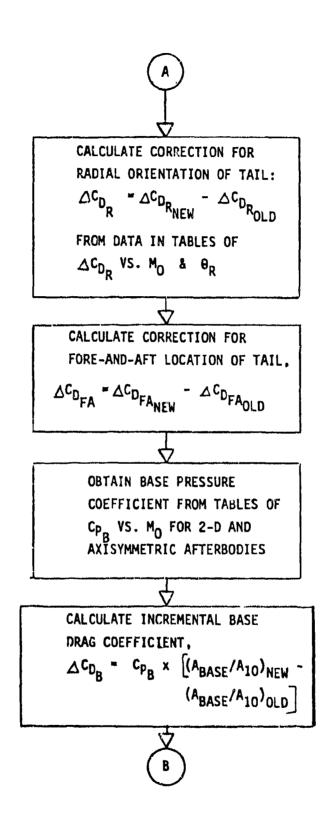
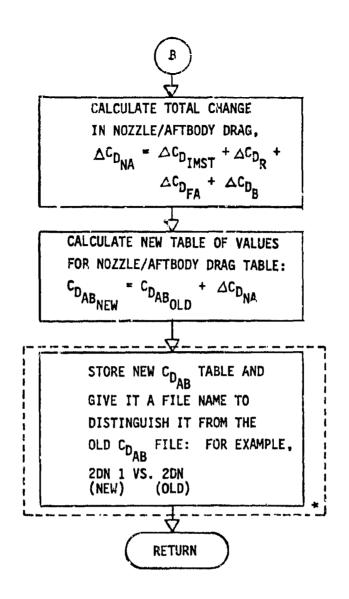


Figure 47. Flow Chart for Nozzle/Aftbody /Drag Procedure (Cont,d)



*ACCOMPLISHED EXTERNALLY TO NORMAL PROGRAM CALCULATION STEPS. SHOWN HERE FOR INFORMATION ONLY.

Figure 47. Flow Chart for Nozzle/Aftbody Drag Procedure (Concluded)

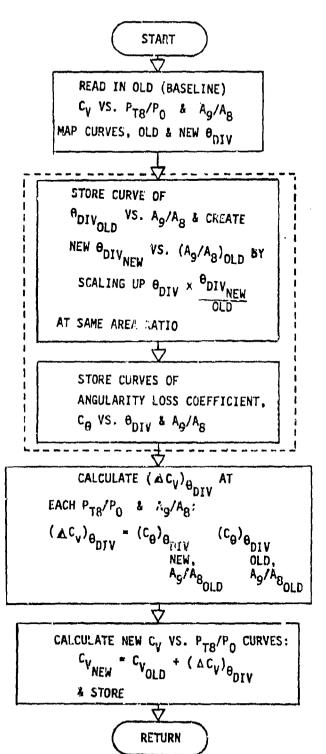


Figure 48. Flow Chart for CFG Derivative Procedure for a Round C-D Nozzle 141

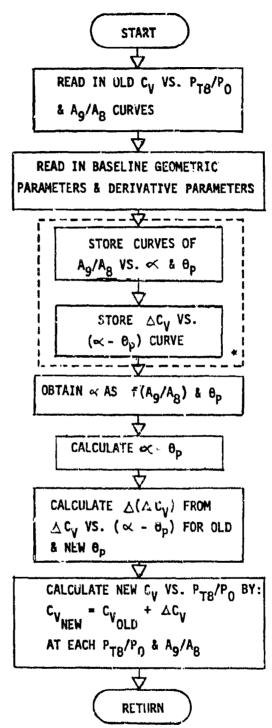


Figure 49. Flow Chart for C_{F_G} Derivative Procedure for a Round Plug Nozzle

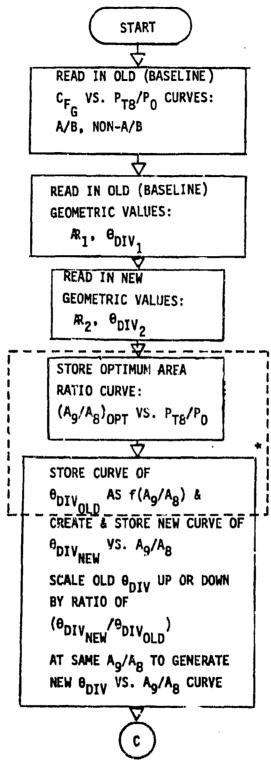


Figure 50. Flow Chart for CrG Derivative Procedure for a 2-D C-D Nozzle

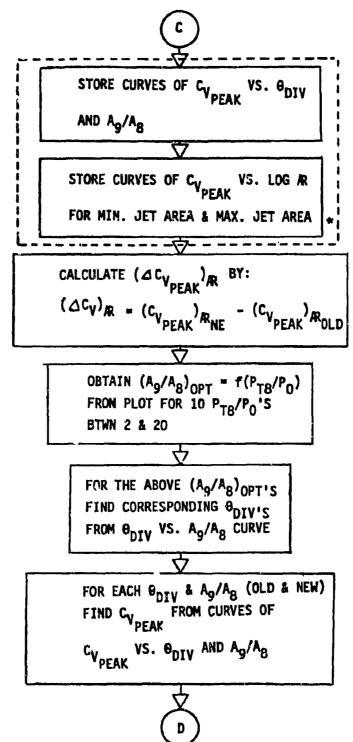


Figure 50. Flow Chart for Cp Derivative Procedure for a 2-D C-D Nozzle (Cont.d)



CALCULATE ($\triangle C_V$)

 $(\Delta c_V)_{\theta_{DIV}} = (c_{V_{PEAK}})_{\theta_{DIV_{NEW}}} - (c_{V_{PEAK}})_{\theta_{DIV_{OLD}}}$

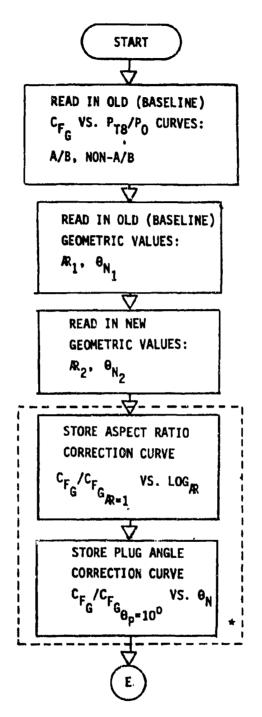
CALCULATE NEW CV VS. PT8/PO CURVES:

 $(c_V)_{NEW} = (c_V)_{OLD} + (\triangle c_V)_{RR} + \triangle c_{V_{OLV}}$

AT EACH P_{TB}/P_{0} FOR BOTH JET AREAS & STORE

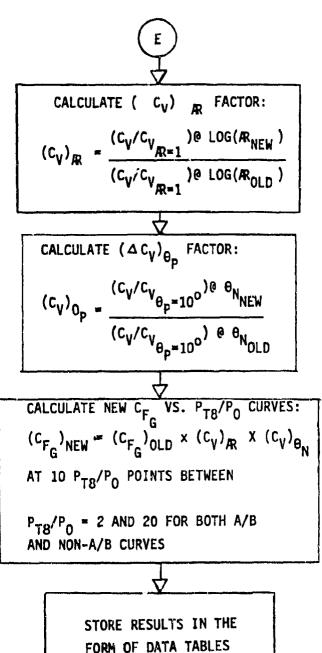


Figure 50. Flow Chart for C_{FB} Derivative Procedure for a 2-D C-D Mozzle (Concluded)



*BUILT INTO BASIC PROGRAM.
SHOWN FOR INFORMATION ONLY.

Figure 51. Flow Chart for CFG Derivative Procedure for a 2-D Plug Nozzle 146



STORE RESULTS IN THE FORM OF DATA TABLES SIMILAR IN FORMAT TO OLD TABLES.

RETURN

Figure 51. Flow Chart for C_{FG} Derivative Procedure for a 2-D Plug Nozzle (Concluded)